PROJECT:
Old Duck Pond Dam Breach
444 Green Street
Gardner, MA 01440
Project No. MWC2450I FT1

ADDENDUM NO. 1 07/02/2025

Posted: 07/02/2025 at 1:37PM EDT

Awarding Authority/Owner:
Mount Wachusett Community College
444 Green Street
Gardner, MA 01440

Reference Contract Documents (drawings and specifications) dated 05/30/2025

The attention of Bidders submitting proposals for the above subject project is called to the following addendum to the specifications and drawings. The items set forth herein, whether of omission, addition, substitution, or clarifications are all to be included in and form a part of the proposal submitted.

THE NUMBER OF THIS ADDENDUM (**1**) MUST BE ENTERED IN THE APPROPRIATE SPACE "B" PROVIDED AFTER THE WORD "NUMBERS" OF THE CONTRACT FORM ENTITLED "FORM FOR GENERAL BID," AND IN SPACE "B" OF THE "FORM FOR SUB-BID."

BID DOCUMENT MODIFICATIONS ARE AS FOLLOWS.

Specifications:

■ Add the following new technical sections. (See attached)
00 99 03 Soil Grain Size Testing Results
00 99 04 Soil Chemical Testing Data
00 99 05 Hydraulic & Hydrologic Analysis

Drawings:

■ Replace the following drawings in their entirety. (See attached)
C-7 Demolition Plan

Clarifications:

GENERAL
RFI #1 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
For the temporary water control and cofferdam, is steel sheeting allowed?
Response: (Prime Designer)
Yes.

RFI #3 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Are large sand bags (greater than 100 lbs. each) allowed to be used for the cofferdam?

Response: (Prime Designer)
No.

RFI #4 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
The drawings reference electric lines. Does the Contractor need to put the electric lines back?
Response: (Prime Designer)
The College previously removed buried electric lines from the dam area which
powered lights on the walking path. The College plans to re-install the electric lines after the project is complete.

RFI #5 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
The Contractor is not allowed to use the roadway adjacent to the tennis courts. Where can the Contractor access the dewatered pond area to install plantings?
Response: (Prime Designer)
The Contractor can access the dewatered pond area from the existing dam.

RFI #6 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Are tracked machines allowed in the dewatered pond area to deliver and install the new plantings?
Response: (Prime Designer)
Yes.

RFI #7 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Do you have information on the watershed?
Response: (Prime Designer)
Yes, attached is a hydraulic and hydrologic analysis.
Attachments:
Hydraulic & Hydrologic Analysis.pdf,

RFI #8 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Is test data available for the site soils?
Response: (Prime Designer)
Yes, attached are results of grain size testing and soil chemical testing.
Attachments:
Soil Chemical Testing Data.pdf, Soil Grain Size Testing Results.pdf,

RFI #9 - Type: General

Drawing ref: -
Section ref: -
Other ref: -
Question:
Does the temporary dewatering bypass pipe need to be removed at the end of the project?
Response: (Prime Designer)
Yes, all temporary works and equipment shall be removed when no longer needed.

RFI #10 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Can extra crushed stone be left at the site after the project?
Response: (Prime Designer)
Yes.

RFI #11 - Type: General
Drawing ref: -
Section ref: -
Other ref: -
Question:
Is the Contractor responsible for filing for the SWPPP?
Response: (Prime Designer)
Yes.

Other Modifications / Attachments:

The following attachment includes additional modifications, clarifications and/or provisions not included in the items above in this Addendum.
See document at the end of document.

All other of the portions of the Contract Documents remain **unchanged**. Please be reminded to acknowledge this Addendum on the bid forms.

ATTACHMENTS

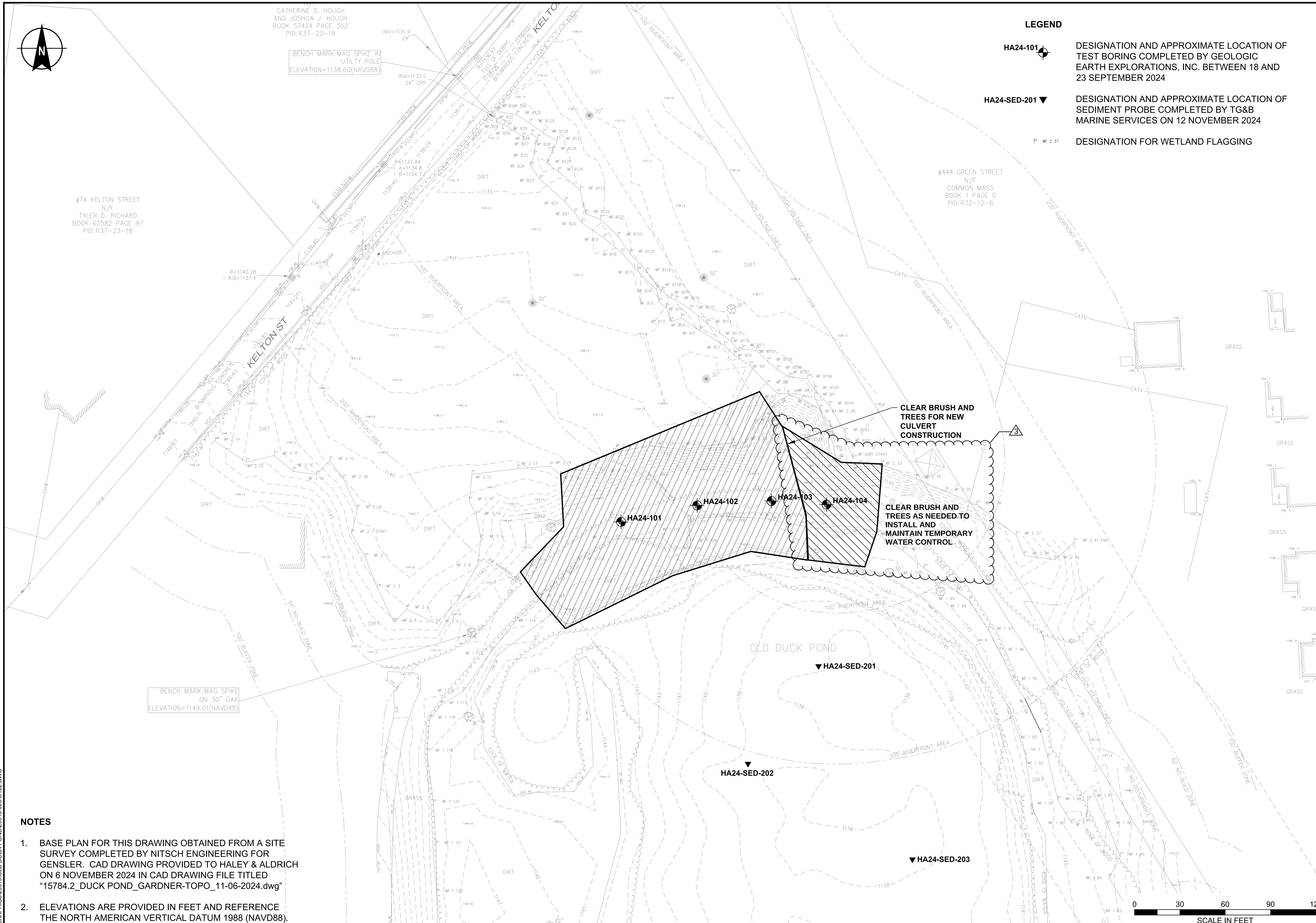
C-7 Demolition Plan
00 99 03 Soil Grain Size Testing Results
00 99 04 Soil Chemical Testing Data
00 99 05 Hydraulic & Hydrologic Analysis
Walkthrough Sign-In Sheet.pdf

--- End of Addendum No. **1** ---

Old Duck Pond Dam Breach Project
Mount Wachusett Community College
Gardner, Massachusetts
Meeting No. 1
July 1, 2025

Sign-In Sheet

Name	Company	Phone	Email
DENIS BELL	HALEY + ALDRICH	617-886-7343	DBELL@HALEYALDRICH.COM
Aaron Gautreau	Charter	857-262-6183	agautreau@charter.us
Dan Galante	T Ford Company	508-726-4086	dan@tford.com
Glen Fox	MWCC	603 316 9385	gfox1@mwcc.mass.edu
Stephanie Kennelly	MWCC	978 630 9147	skennelly@mwcc.mass.edu
CHUCK SKERRY	DAVID G. ROACH & SONS	413-345-0524	CHUCK.SKBRRY@DGRSONS.COM
Andrew Lambert	ET and L Corp.	978-897-4363	alambert4@etlcorp.com
Sam Hills	ET and L Corp.	978-897-4363	Shills@etlcorp.com



LEGEND

HA24-101 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING COMPLETED BY GEOLOGIC EARTH EXPLORATIONS, INC. BETWEEN 18 AND 23 SEPTEMBER 2024

HA24-SED-201 ▼ — DESIGNATION AND APPROXIMATE LOCATION OF SEDIMENT PROBE COMPLETED BY TG&B MARINE SERVICES ON 12 NOVEMBER 2024

WF 2 37 — DESIGNATION FOR WETLAND FLAGGING

NOTES

1. BASE PLAN FOR THIS DRAWING OBTAINED FROM A SITE SURVEY COMPLETED BY NITSCH ENGINEERING FOR GENSLER. CAD DRAWING PROVIDED TO HALEY & ALDRICH ON 6 NOVEMBER 2024 IN CAD DRAWING FILE TITLED "15784.2_DUCK POND_GARDNER-TOPO_11-06-2024.dwg"
2. ELEVATIONS ARE PROVIDED IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88).

Saved by: DTE Printed: 6/18/2025 6:58 AM Sheet: D122
J:\GRAPHICS\29913\OLD DUCK POND\29913-028-D122.DWG

HALEY & ALDRICH, INC.
465 Medford Street, Suite 2200
Boston, MA 02129-1400
Tel: 617.886.7400
www.haleyaldrich.com

Project No.:	29913-028
Scale:	AS SHOWN
Date:	9 JANUARY 2025
Drawn By:	DTE
Designed By:	DJB
Checked By:	DJB
Approved By:	DJB
Stamp:	

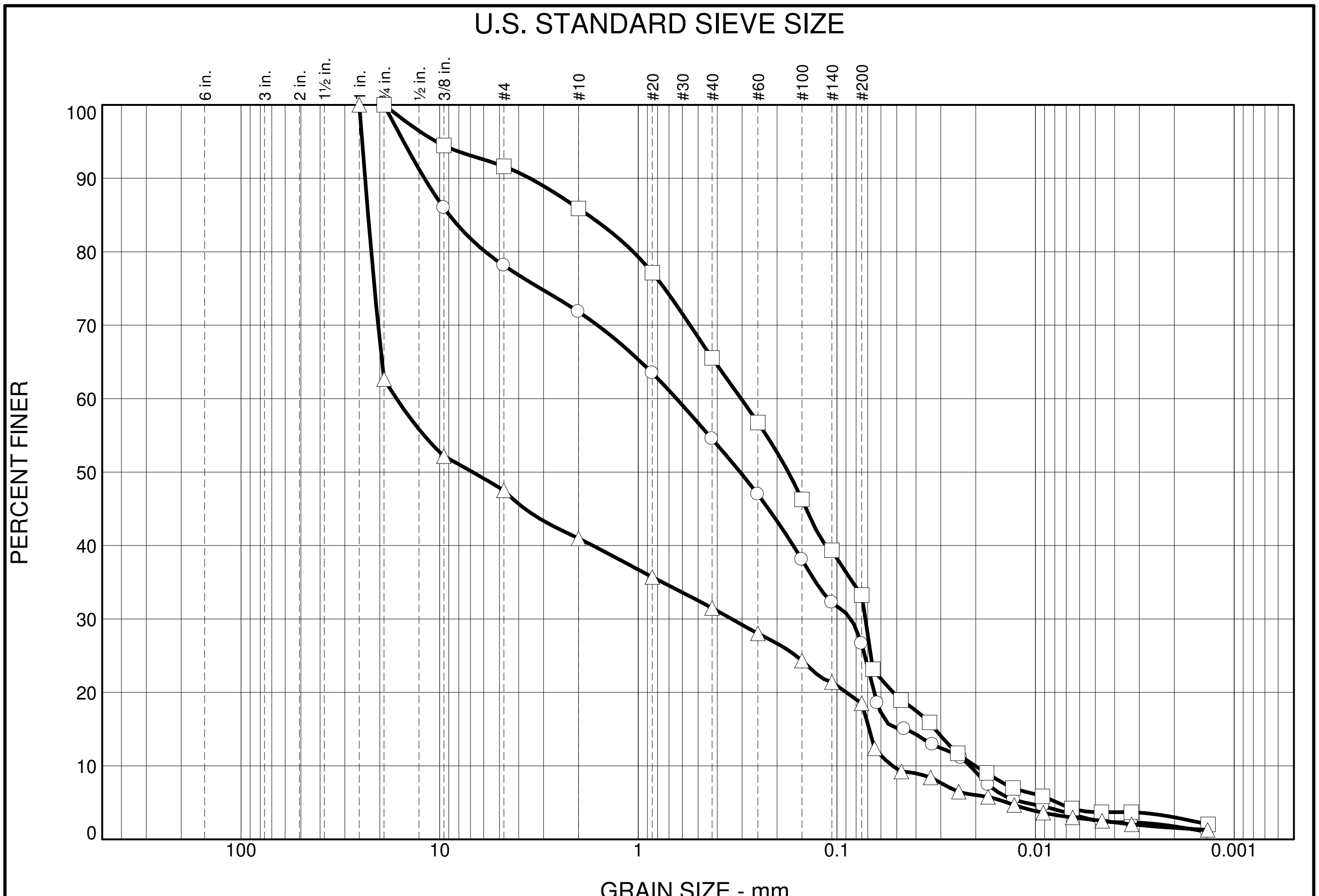
Rev.	Description	By	Date
3	ADDENDUM #1	DJB	7/2/2025
2	BID SET	DJB	5/30/2025
1	PERMIT SET	DJB	1/9/2025

OLD DUCK POND DAM BREACH

Gardner, Massachusetts

DEMOLITION PLAN

C-7



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	21.9	6.3	17.3	27.9	24.8	1.8
□	0.0	0.0	8.4	5.7	20.3	32.3	30.3	3.0
△	0.0	37.3	15.2	6.5	9.5	13.0	16.9	1.6

	Expl. No.	Sample No.	Depth (ft)	Atterberg Limits %			Water Content (%)	C_u	C_c	USCS
				W_L	W_P	I_P				
○	HA24-101	S05	8.0-10.0				17.7	30.03	0.53	SM
□	HA24-102	S02	2.0-4.0				22.7	15.08	0.85	SM
△	HA24-104	S05	14.0-15.4				13.0	314.98	0.13	GM

	Sample Description
○	Light brown silty sand with gravel
□	Yellow-brown silty sand
△	Light brown silty gravel with sand

Remarks:

Samples HA24-101 S05 and HA24-102 S02 contained less than 500 grams of material available for testing in accordance with ASTM D422.

HALEY ALDRICH

Old Duck Pond
Gardner, Massachusetts

GRAIN SIZE DISTRIBUTION

DATE: 10/7/2024

FILE NO: 029913-028

TABLE I
SUMMARY OF CHEMICAL ANALYTICAL RESULTS
SOIL SAMPLES
OLD DUCK POND DAM
MOUNT WACHUSETT COMMUNITY COLLEGE
GARDNER, MASSACHUSETTS
FILE NO. 029913-028

Location Name / Sample Name / Sample Date / Lab Sample ID / Sample Depth (bgs) / Soil Description	MCP Reportable Concentration RCS-1 2024	HA24-101 / HA24-101_0-5 / 09/23/2024 / L2454565-01 / 0 - 5 (ft) / FILL	HA24-101 / HA24-101_5-8 / 09/23/2024 / L2454565-02 / 5 - 8 (ft) / FILL	HA24-102 / HA24-102_0-5 / 09/20/2024 / L2454367-01 / 0 - 5 (ft) / FILL	HA24-102 / HA24-102_5-9 / 09/20/2024 / L2454367-02 / 5 - 9 (ft) / FILL	HA24-103 / HA24-103_0-5 / 09/19/2024 / L2454018-01 / 0 - 5 (ft) / FILL	HA24-103 / HA24-103_5-10 / 09/19/2024 / L2454018-02 / 5 - 10 (ft) / FILL	HA24-104 / HA24-104_0-5 / 09/18/2024 / L2453671-01 / 0 - 5 (ft) / FILL	HA24-104 / HA24-104_5-10 / 09/18/2024 / L2453671-02 / 5 - 10 (ft) / FILL
Volatile Organic Compounds (mg/kg)									
2-Butanone (Methyl Ethyl Ketone)	4	ND (0.01)	0.042	ND (0.0093)	ND (0.0095)	ND (0.0077)	ND (0.011)	ND (0.012)	ND (0.0092)
Acetone	6	ND (0.026)	0.2	ND (0.023)	ND (0.024)	ND (0.019)	ND (0.027)	ND (0.031)	ND (0.023)
SUM of Volatile Organic Compounds	NA	ND	0.242	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds (mg/kg)									
Acenaphthylene	2	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.32	ND (0.15)
Anthracene	1000	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.18	ND (0.11)
Benzo(a)anthracene	20	ND (0.11)	ND (0.15)	0.11	ND (0.11)	ND (0.6)	ND (0.11)	0.58	ND (0.11)
Benzo(a)pyrene	2	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.76	ND (0.15)
Benzo(b)fluoranthene	20	ND (0.11)	ND (0.15)	0.13	ND (0.11)	ND (0.6)	ND (0.11)	0.91	ND (0.11)
Benzo(g,h,i)perylene	1000	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.54	ND (0.15)
Benzo(k)fluoranthene	200	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.29	ND (0.11)
bis(2-Ethylhexyl)phthalate	100	ND (0.19)	ND (0.24)	ND (0.18)	ND (0.19)	ND (0.99)	0.3	ND (0.18)	ND (0.19)
Chrysene	200	ND (0.11)	ND (0.15)	0.12	ND (0.11)	ND (0.6)	ND (0.11)	0.63	ND (0.11)
Dibenz(a,h)anthracene	2	ND (0.08)	ND (0.1)	ND (0.076)	ND (0.08)	ND (0.42)	ND (0.077)	0.1	ND (0.078)
Fluoranthene	1000	ND (0.11)	ND (0.15)	0.16	ND (0.11)	ND (0.6)	ND (0.11)	1.2	ND (0.11)
Indeno(1,2,3-cd)pyrene	20	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.44	ND (0.15)
Phenanthrene	10	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.54	ND (0.11)
Pyrene	1000	ND (0.11)	ND (0.15)	0.18	ND (0.11)	ND (0.6)	ND (0.11)	1.1	ND (0.11)
SUM of Semi-Volatile Organic Compounds	NA	ND	ND	0.7	ND	ND	0.3	7.59	ND
Total Petroleum Hydrocarbons (mg/kg)									
Petroleum hydrocarbons	1000	ND (38.3)	147	52.6	53.8	106	ND (35.8)	103	ND (37)
Inorganic Compounds (mg/kg)									
Antimony	20	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Arsenic	20	8.88	10.8	11.5	12.5	12.5	11.9	15.5	14.5
Barium	1000	24.6	37.9	42.7	102	61.3	87.4	36	38.8
Beryllium	100	ND (0.44)	ND (0.581)	ND (0.418)	ND (0.45)	ND (0.48)	ND (0.44)	ND (0.444)	ND (0.433)
Cadmium	80	ND (0.88)	ND (1.16)	ND (0.835)	ND (0.9)	ND (0.961)	ND (0.881)	ND (0.888)	ND (0.866)
Chromium	100	9.12	14.7	16.2	25.3	23.3	37.8	16.2	14.1
Lead	200	7.06	13.5	7.84	5.97	8.33	ND (4.4)	7.3	5.57
Mercury	20	ND (0.076)	ND (0.105)	ND (0.077)	ND (0.082)	ND (0.085)	ND (0.078)	ND (0.082)	ND (0.073)
Nickel	700	6.07	6.22	9.42	13	13	22.1	8.65	7.9
Selenium	400	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Silver	100	ND (0.88)	ND (1.16)	ND (0.835)	ND (0.9)	ND (0.961)	ND (0.881)	ND (0.888)	ND (0.866)
Thallium	8	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Vanadium	500	11.1	17.2	15.4	31.1	21.1	24.1	15.1	13.4
Zinc	1000	18.5	28.2	28	44.7	36	26	25.2	22.8
PCBs (mg/kg)									
Aroclor-1016 (PCB-1016)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1221 (PCB-1221)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1232 (PCB-1232)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1242 (PCB-1242)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1248 (PCB-1248)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1254 (PCB-1254)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1260 (PCB-1260)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1262 (PCB-1262)	NA	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1268 (PCB-1268)	NA	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Polychlorinated biphenyls (PCBs)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Other									
Total Solids (%)	NA	86.5	66.6	90.9	86	81.5	90	89.7	87.3
Reactive Cyanide (mg/kg)	NA	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)
Reactive Sulfide (mg/kg)	NA	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)
Ignitability (Flashpoint)	NA	NI	NI	NI	NI	NI	NI	NI	NI
pH (lab) (pH units)	NA	6.89	6.8	7.7	7.64	7.11	6.92	8.18	8.21
Conductivity (umhos/cm)	NA	22	22	21	24	15	24	25	33

TABLE II
SUMMARY OF CHEMICAL ANALYTICAL RESULTS
SEDIMENT SAMPLES
OLD DUCK POND DAM
MOUNT WACHUSETT COMMUNITY COLLEGE
GARDNER, MASSACHUSETTS
File No. 029913-028

Precharacterization Grid						
Location Name	HA24-SED-201	HA24-SED-202	HA24-SED-203	HA24-SED-204	HA24-SED-205	HA24-SED-206
Sample Name	HA24-SED-201_0-2	HA24-SED-202_0-2	HA24-SED-203_0-2	HA24-SED-204_0-2	HA24-SED-205_0-2	HA24-SED-206_0-2
Sample Date	11/12/2024	11/12/2024	11/12/2024	11/12/2024	11/12/2024	11/12/2024
Lab Sample ID	L2466236-06	L2466236-05 L2467789-01	L2466236-04	L2466236-03 L2467789-03	L2466236-02 L2467789-02	L2466236-01
Sample Depth (bgs)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)
Volatile Organic Compounds (mg/kg)						
2-Butanone (Methyl Ethyl Ketone)	0.37	0.32	0.22	0.26	0.12	0.28
Acetone	1.4	1.3	1.1	1.1	0.5	1.1
SUM of Volatile Organic Compounds	1.77	1.62	1.32	1.36	0.62	1.38
Semi-Volatile Organic Compounds (mg/kg)						
Benzo(b)fluoranthene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	3.4	2.3
Chrysene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	2.5	ND (1.8)
Fluoranthene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	5.1	2.9
Pyrene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	3.6	2.1
SUM of Semi-Volatile Organic Compounds	ND	ND	ND	ND	14.6	7.3
Total Petroleum Hydrocarbons (mg/kg)						
Petroleum hydrocarbons	ND (483)	ND (336)	ND (309)	409	ND (311)	325
PCBs (mg/kg)						
Aroclor-1016 (PCB-1016)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1221 (PCB-1221)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1232 (PCB-1232)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1242 (PCB-1242)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1248 (PCB-1248)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1254 (PCB-1254)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1260 (PCB-1260)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1262 (PCB-1262)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1268 (PCB-1268)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Polychlorinated biphenyls (PCBs)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Inorganic Compounds (mg/kg)						
Antimony	**ND (40.2)**	**ND (27.6)**	**ND (25.6)**	**ND (28.9)**	**ND (25.7)**	**ND (23.7)**
Arsenic	10.4	**24**	9.65	11.2	**25.4**	15.3
Barium	89.8	86.7	56.1	63.2	80.6	64.6
Beryllium	ND (4.02)	ND (2.76)	ND (2.56)	ND (2.89)	ND (2.57)	ND (2.37)
Cadmium	ND (8.05)	ND (5.52)	ND (5.11)	ND (5.78)	ND (5.14)	ND (4.74)
Chromium	11.2	23.8	8.81	12.6	29.4	21.8
Lead	45.5	105	ND (25.6)	107	133	75.3
Mercury	ND (0.764)	ND (0.476)	ND (0.429)	ND (0.474)	ND (0.416)	ND (0.443)
Nickel	ND (20.1)	20.4	ND (12.8)	15.6	21.4	16.9
Selenium	ND (40.2)	ND (27.6)	ND (25.6)	ND (28.9)	ND (25.7)	ND (23.7)
Silver	ND (8.05)	ND (5.52)	ND (5.11)	ND (5.78)	ND (5.14)	ND (4.74)
Thallium	**ND (40.2)**	**ND (27.6)**	**ND (25.6)**	**ND (28.9)**	**ND (25.7)**	**ND (23.7)**
Vanadium	11.6	34	7.33	20.3	41.1	21.2
Zinc	120	408	38.5	191	479	183
TCLP Inorganic Compounds (mg/L)						
Lead	-	ND (0.5)	-	ND (0.5)	ND (0.5)	-
Other						
Total Solids (%)	9.64	14	14.8	13.8	15.3	16.2
Reactive Cyanide (mg/kg)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)
Reactive Sulfide (mg/kg)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)
Ignitability (Flashpoint)	NI	NI	NI	NI	NI	NI
pH (lab) (pH units)	6.13	5.97	5.77	5.45	5.8	5.49
Conductivity (umhos/cm)	300	270	230	270	330	480

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
mg/L: milligram per liter
umhos/cm: micromhos per centimeter

HALEY ALDRICH

CALCULATIONS

Client	Mount Wachusett Community College	File No.	29913-028
Project	Old Duck pond Dam Breach	Sheet	1 of 1
Subject	Hydraulic and Hydrologic Analysis	Date	31-Jan-25
		Computed by	DJB
		Checked by	

Hydraulic and Hydrologic Analysis

The following hydraulic and hydrologic analysis is based on a breach of Old Duck Pond Dam and installing a 6 ft wide by 4 ft high culvert with an invert at El. 1140. The below rainstorms and associated peak flows were determined using the computer program StreamStats developed and published by the USGS. The developed flows were calibrated using outputs from the application DSS-WISE Lite supported by FEMA and the unit hydrograph developed in accordance with the Natural Resources Conservation Service (NRCS) Unit Hydrograph webpage and UHtransformerVer3, dated August 2016.

Watershed Data
Total Drainage Area = 0.08 sq. mi.
Ponds and swamp areas = 7.4%
Forested Area = 46%
Average Slope = 5%
Drainage Length = 3,200 ft

Proposed Design Water Elevation for Dam Breach

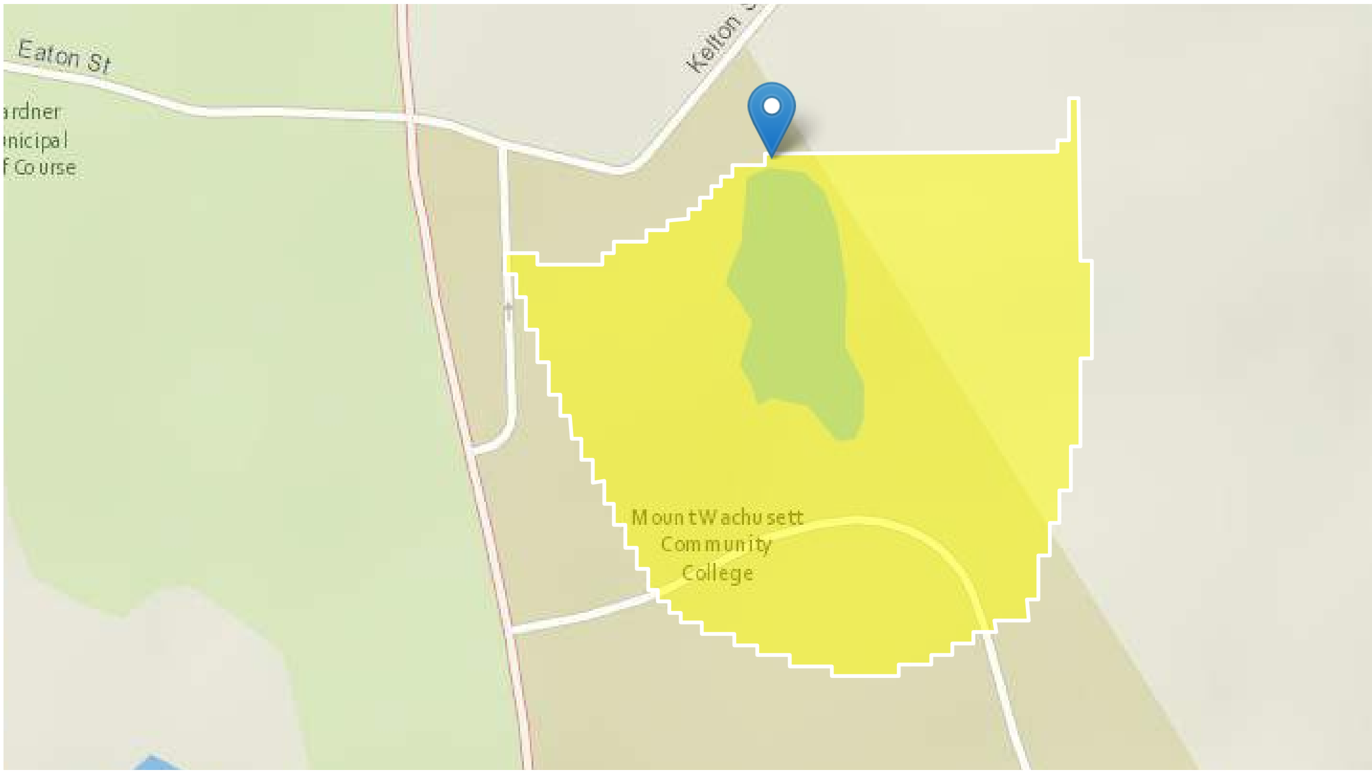
Design Storm Event				
Annual Exceedance Probability (%, AEP)	Return Period (YR)	Peak Flow (CFS)	Pond EL. (FT)	Water Depth Above El. 1140 Normal Pool. (FT)
--	0	0	1140.0	0.0
50	2	7.1	1140.5	0.5
20	5	12.7	1140.8	0.8
10	10	17.6	1141.0	1.0
4	25	25.1	1141.2	1.2
2	50	31.5	1141.5	1.5
1	100	38.6 (38.4)	1141.7	1.7
0.5	200	46.5	1141.9	1.9
0.2	500	58.4	1142.2	2.2

Note: Results from StreamStats were calibrated for the 1% annual exceedance probability flood using WS-WISE LITE.

G:\29913\027-OldDuckPond\H-H\[2025-0131-HAI-DuckPondFlowes-01.xlsx]Page 1

Old Duck Pond Dam Breach

Region ID: MA
Workspace ID: MA20250202202209989000
Clicked Point (Latitude, Longitude): 42.59797, -71.98414
NHD Stream GNIS Name of Click Point: Stream name not found
Time: 2025-02-02 15:22:33 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0748	square miles
ELEV	Mean Basin Elevation	1160	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	7.44	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0748	square miles	0.16	512
ELEV	Mean Basin Elevation	1160	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	7.44	percent	0	32.3

Peak-Flow Statistics Disclaimers [Peak Statewide 2016 5156]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

Statistic	Value	Unit
50-percent AEP flood	7.12	ft^3/s
20-percent AEP flood	12.7	ft^3/s
10-percent AEP flood	17.6	ft^3/s
4-percent AEP flood	25.1	ft^3/s
2-percent AEP flood	31.5	ft^3/s
1-percent AEP flood	38.6	ft^3/s
0.5-percent AEP flood	46.5	ft^3/s
0.2-percent AEP flood	58.4	ft^3/s

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

NHD Features of Delineated Basin

NHD Streams Intersecting Basin Delineation Boundary

This functionality attempts to find the stream name at the delineation point. The name of the nearest intersecting National Hydrography Dataset (NHD) stream is selected by default to appear in the report above. NHD streams do not correspond to the StreamStats stream grid and may not be accurate. If you would like a different stream to appear in the above section, please make a selection below.

No NHD streams intersect the delineated basin.

Watershed Boundary Dataset (WBD) HUC 8 Intersecting Basin Delineation Boundary

This functionality attempts to find the intersecting HUC 8 of the delineated watershed. HUC boundaries do not correspond to the StreamStats data and may not be accurate.

HUC 8	Name
01080202	Millers River
01070004	Nashua River

NHD Hydrologic Features Citations

U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6. (https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6) U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4. (https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4)

Application Version: 4.26.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

HALEY & ALDRICH, INC.
600 S Meyer Avenue
Tucson, AZ 857011
520.289.8600

MEMORANDUM

23 February 2024
File No. 29913-027

TO: Denis Bell, P.E.
Haley & Aldrich, Inc.

FROM: Christopher Langham, Abby Haneke
Haley & Aldrich, Inc.

SUBJECT: Emergency Action Plan
Summary of Study – Extent of Inundation
Old Duck Pond Dam
NID MA 02784
Gardner, Massachusetts

Introduction

This memorandum summarizes the methods used by Haley & Aldrich, Inc. (Haley & Aldrich) to determine the extent of inundation in the event of a dam breach at the Old Duck Pond Dam (NID MA02784), in Gardner, Massachusetts.

Haley & Aldrich completed this inundation study to aid in the development of an Emergency Action Plan (EAP) for the Old Duck Pond Dam, as required by the Commonwealth of Massachusetts General Laws, M.G.L. 253, Section 44, Chapter 302 C.M.R. 10.00, “Dam Safety, dated February 10, 2017”. The purpose of the EAP is to establish a basic plan of action if conditions at the dam indicate the potential for dam failure or if any individual observes and reports a dangerous condition developing at the dam.

Elevation Datum

Elevations referenced in this memorandum are provided in NAVD88.

Old Duck Pond Dam

In the Design Consultants Inc November 2018 “Old Duck Pond Dam Phase I Inspection/Evaluation” report, the Old Duck Pond Dam was classified as a SIGNIFICANT hazard structure. The following sections of this report summarize an inundation study for Old Duck Pond Dam, which will be used in the 2024 Old Duck Pond Dam EAP.

The Old Duck Pond Dam is an earthen embankment with the spillway blocked. The dam is approximately 400-feet long with a maximum height of approximately 12-feet. Embankment slopes are graded to between 1H to 2H:1V slope downstream with some locations vertical. The upstream embankment was flooded and couldn't be observed The maximum storage volume with the water level at the top of the Dam is approximately 61.4 acre-feet. The storage volume with the water level at the normal pool level is approximately 26.6 acre-feet.

Methods to Determine Inundation Extent

To determine the extent of inundation during a potential dike failure, Haley & Aldrich utilized the FEMA supported DSS-WISE Lite model for inundation mapping. The DSS-WISE Lite modeling program allows the user to input dam dimensions and breach parameters to run in a dam breach simulation. The model outputs a Simulation Report. The Simulation Report outlines all model inputs and assumptions, as well as the basic results of the simulation, including inundation maps overlaid on the DEM image.

Haley & Aldrich used the FEMA supported DSS-WISE Lite model to run two simulations: a "rainy-day breach" and a "sunny-day breach". The sunny-day breach model run is designed to simulate a dam breach due to a piping failure under otherwise normal conditions. The rainy-day breach model run is designed to simulate a dam failure due to overtopping under storm/high-water conditions.

HYDROGRAPH GENERATION

The DSS-WISE Lite modeling program allows the user to choose whether to input simulation parameters through a "Reservoir Type" simulation or a "Hydrograph Type" simulation. The "Reservoir Type" simulation requires the user to input specific parameters to model the impounded reservoir and breach geometry. In the "Hydrograph Type" simulation, the user provides a breach hydrograph, which the model propagates downstream. For this study, Haley & Aldrich utilized the "Hydrograph Type" simulation in DSS-WISE Lite.

Breach Hydrograph

To generate a breach hydrograph for the Old Duck Pond Dam, Haley & Aldrich used the "Dam Breach Hydrograph TR-60 version 3" excel spreadsheet provided on the Natural Resources Conservation Services (NRCS) website.

This spreadsheet allows the user to calculate a breach hydrograph by inputting dam dimensions. The spreadsheet references the NRCS National Engineering Manual (NEM) section 520.2 and uses the TR-60 equations from that reference to calculate a breach hydrograph.

Haley & Aldrich input the following values into this spreadsheet to calculate a breach hydrograph for the Old Duck Pond Dam. This hydrograph generation assumes a full pool with no antecedent flow.

Dam Crest Height = 12 ft

Water Surface Elevation at Time of Breach = 1145.76ft
Dam Top Width = 15-20 ft
Dam Side Slope (upstream) = Unknown
Dam Side Slope (downstream) = 1-2
Valley Floor Elevation = Unknown
Reservoir Volume at Time of Breach = 61.4 acre-feet
Valley Width at Dam Axis and Water Surface Elevation = Unknown
Timestep for Breach Hydrograph = 5 Minutes

These calculations and resulting breach hydrograph can be found in Attachment A of this memorandum.

Unit Hydrograph

To generate a unit hydrograph (to model storm/high-water conditions for the rainy-day simulation), Haley & Aldrich used the “Unit Hydrograph Transformer” excel spreadsheet provided on the NRCS website.

The spreadsheet allows the user to calculate a dimensionless SCS unit hydrograph that can be used to represent a discharge versus time hydrograph for any given watershed. This calculation uses a formula provided in the NRCS document “NEH 630 Hydrology”, chapter 16, equation 16A-13. The user inputs time of concentration, drainage area, and peak rate factor to the spreadsheet, and it calculates the unit hydrograph and S-curves for the given information.

For the Old Duck Pond Dam, Haley & Aldrich input the following values into this spreadsheet:

Time of Concentration = 1.4 Hours
Drainage Area = 0.07 mi^2
Peak Rate Factor = 484 (dimensionless)

These calculations and resulting unit hydrograph can be found in Attachment B of this memorandum.

DSS-WISE LITE SIMULATIONS

Sunny-Day Breach

To model a sunny-day breach scenario, Haley & Aldrich input the NRCS spreadsheet-generated breach hydrograph into DSS-WISE Lite. The breach hydrograph used assumes a breach scenario with a full pool and no antecedent flow at the time of the breach. This breach hydrograph showed a peak flow rate during the breach of about 1,596 cubic feet per second (cfs). The input hydrograph can be found in Attachment C of this memorandum.

In addition to the breach hydrograph, Haley & Aldrich also input the following parameters into the DSS-WISE Lite Prep Tool:

Impounding Structure Characteristics

Structure Type:	Embankment
Crest Elevation (ft):	1144.26
Length (ft):	371

Failure Conditions

Failure Mode:	Sudden and Complete Breach
Breach Location: (Latitude/Longitude)	42.5978205568/ -71.984286

The DSS-WISE Lite simulation for a sunny-day breach estimated that the potential flood (2 ft or greater in depth) would travel about 0.9 miles downstream of the Old Duck Pond Dam, and generated inundation maps based on these inputs.

The sunny-day Simulation Report (including inundation maps) can be found in Attachment D of this memorandum.

Rainy-Day Breach

To model a rainy-day breach scenario, Haley & Aldrich used both the unit hydrograph and the breach hydrograph in tandem to simulate the overtopping of the dam. The peak flows of each hydrograph were added together to create a rainy-day peak flow rate during the breach of approximately 9,217 cfs. This input hydrograph can be found in Attachment C of this memorandum.

In addition to the rainy-day breach hydrograph, Haley & Aldrich also input the following parameters into the DSS-WISE Lite Prep Tool:

Impounding Structure Characteristics

Structure Type:	Embankment
Crest Elevation (ft):	1144.26
Length (ft):	371

Failure Conditions

Failure Mode:	Sudden and Complete Breach
Breach Location: (Latitude/Longitude)	42.5977287693/ -71.9841222979

The DSS-WISE Lite simulation for a rainy-day breach estimated that the potential flood (2 ft or greater in depth) would travel about 0.9 miles downstream of the Dow Brook Reservoir Dam, and generated inundation maps based on these inputs.

The rainy-day Simulation Report (including inundation maps) can be found in Attachment E of this memorandum.

Enclosed Attachments:

- Attachment A – NRCS Breach Hydrograph Calculation
- Attachment B – NRCS Unit Hydrograph Calculation
- Attachment C – DSS-WISE Lite Input Hydrographs
- Attachment D – Sunny-Day Simulation Report
- Attachment E – Rainy-Day Simulation Report

References

FEMA supported DSS-WISE Lite web application.

Haley & Aldrich, Inc. “Dow Brook Reservoir Dam Phase 1 Inspection/Evaluation” dated August 29, 2017.

Natural Resources Conservation Service (NRCS) Dam Breach Hydrograph webpage and “DamBreachHydrographTR60ver3” excel spreadsheet dated July 3, 2018.

Natural Resources Conservation Service (NRCS) Unit Hydrograph webpage and “UHtransformerVer3” excel spreadsheet dated August 2016.

G:\29913\027-OldDuckPond\EAP\Technical Memo\2024-0223-HAI_SummaryofInundationStudy-TechnicalMemo_D1.docx

Attachment A

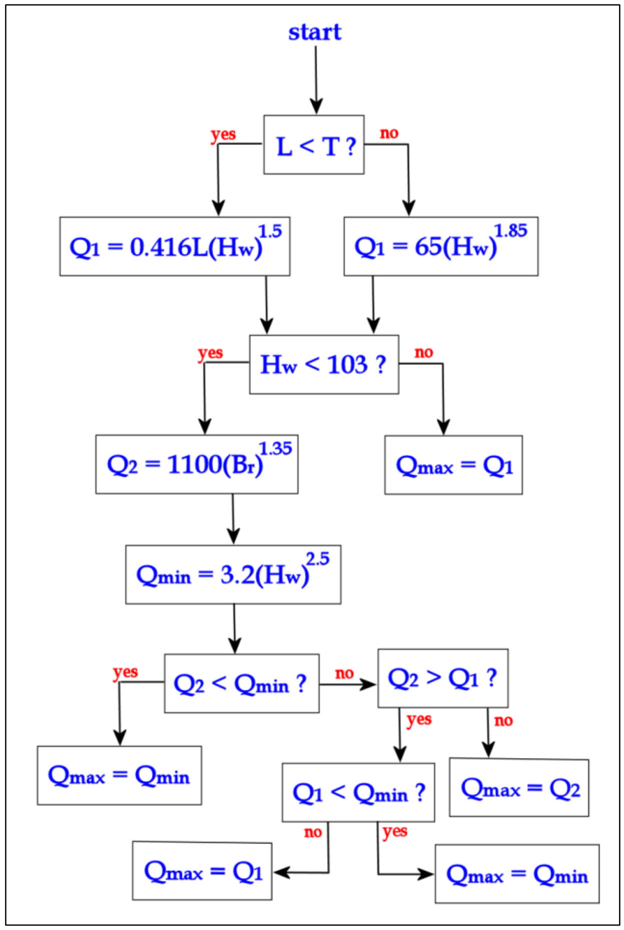
NRCS Breach Hydrograph Calculation

Welcome to DamBreachHydrographTR60.

This tool takes dam embankment and reservoir storage information as input and computes a dam breach peak outflow, using TR-60 equations, and an associated dam breach hydrograph, using the TR-66 AttKin curvilinear routing equations.

This button opens a web page: go get TR-60 and / or TR-66

The flow chart at right shows the TR-60 guidance, which depends on key factors, such as whether the reservoir head at breach time is more or less than 103 feet, and the volume of water stored behind the dam.



The user must insert input on the data sheet in the gray-shaded cells. The output is automatically computed in the output section, light blue cells.

In addition, the breach outflow hydrograph is automatically generated, given the user-desired hydrograph timestep. (This timestep may be chosen based on intended use in other programs, such as HecRAS.)

A button on the data sheet gives the user the option to have the program automatically adjust the graph scale.

NOTE:

The user must decide on a reasonable "floor elevation" from which H_w is determined.
For dams on steep streams the choice of floor elevation may significantly effect results.
The user may wish to select a floor elevation as high as the "alt floor" as shown in the sketch on the data sheet.
For steep streams the selection of floor elevation may be guided by the engineering judgement of the reasonable maximum depth a breach may penetrate into the embankment.

See the NRCS National Engineering Manual (NEM), section 520.2 on Dams for more information. go get NEM 520.2 on Dams

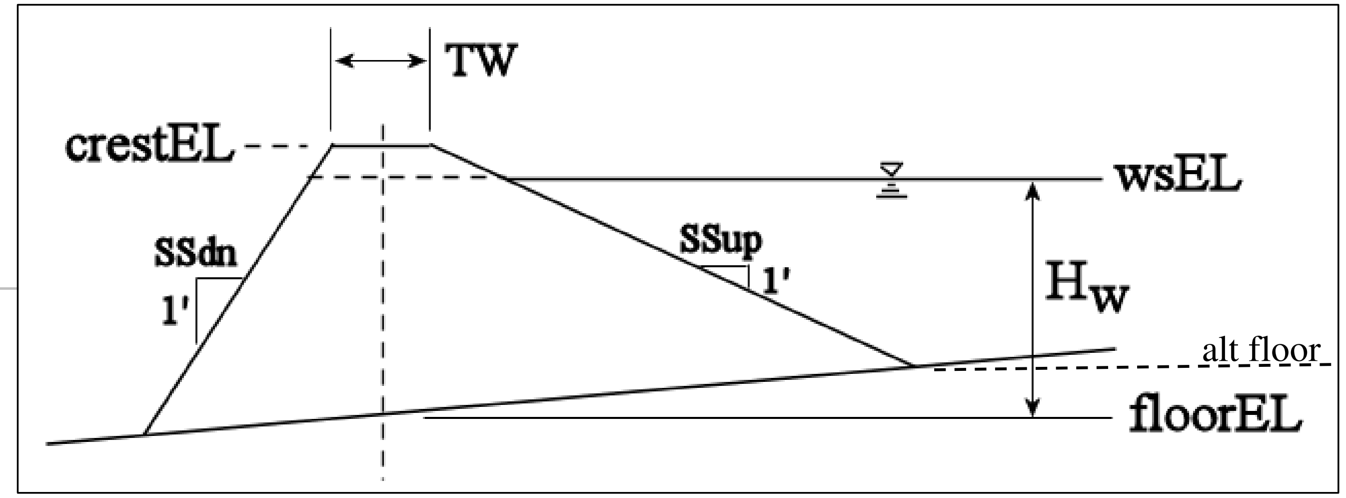
Dambreach Hydrographs via TRs 60 & 66 NRCS guidance

version 3, July 2018

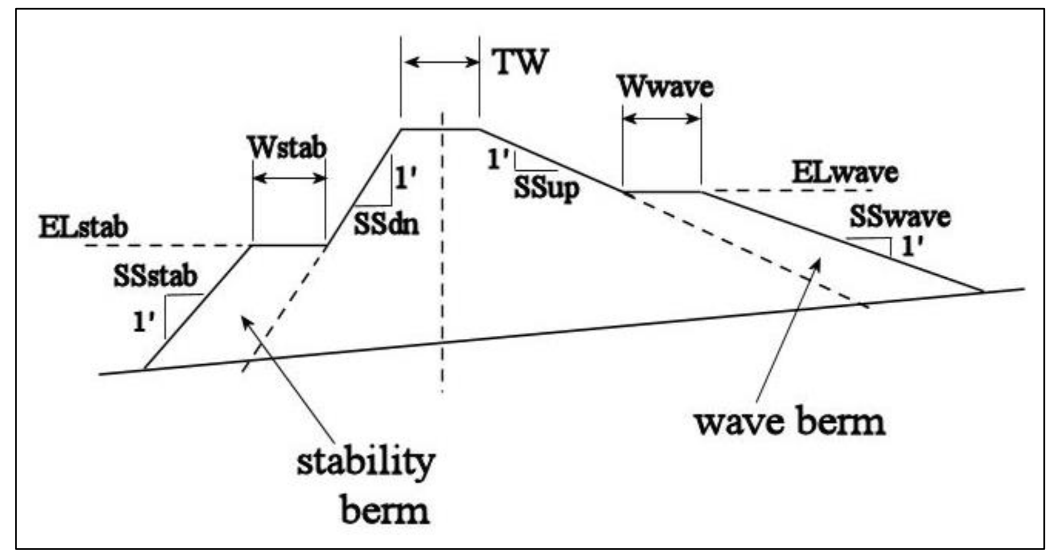
Input data required:

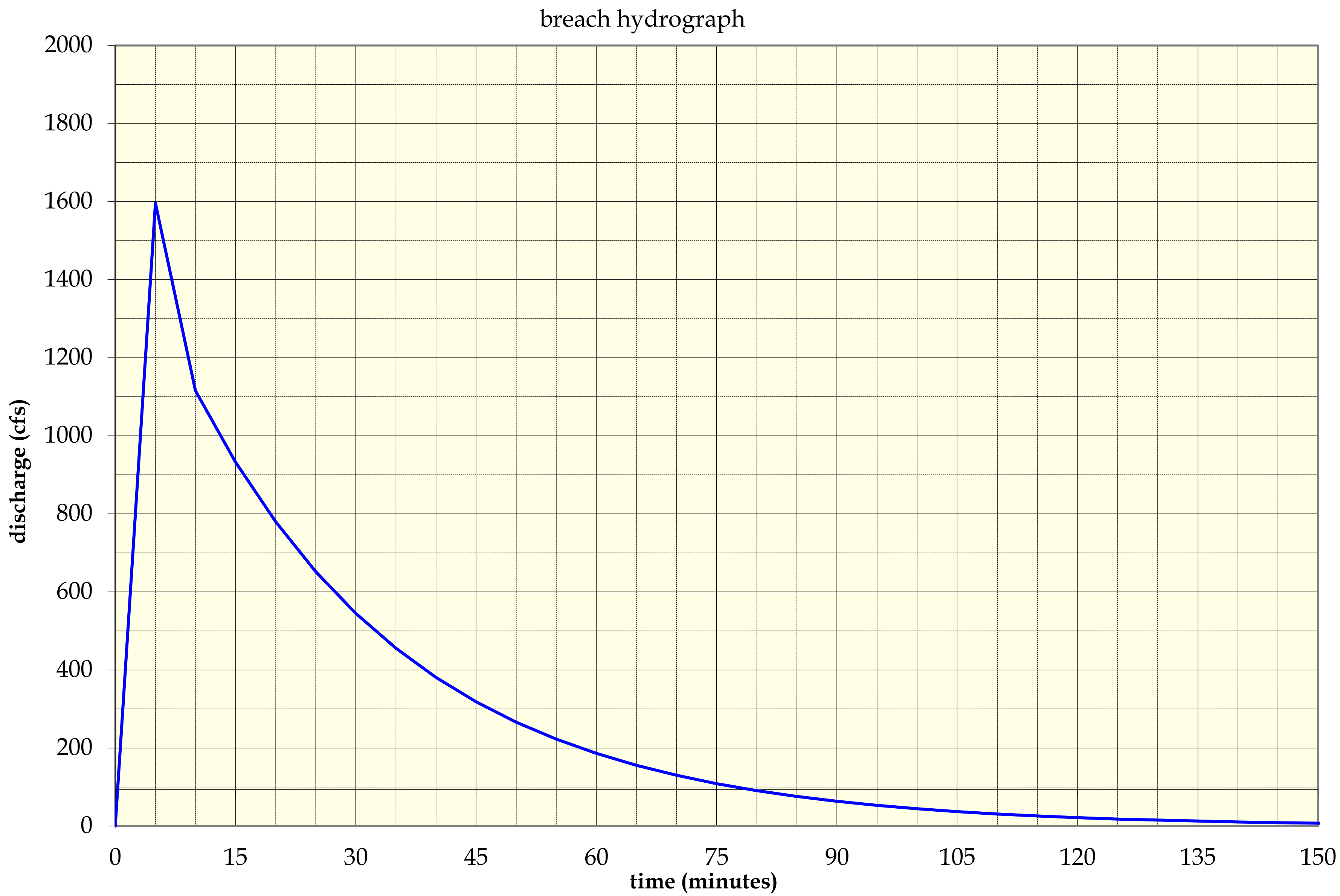
data	variable	explanation
1145.76	crestEL	dam crest elevation
1145.76	wsEL	w.s. elev at time of breach
30	TW	dam top width (feet)
1	SSup	dam side slope (upstream, SSup:1)
2	SSdn	dam side slope (downstream, SSdn:1)
1133.76	floorEL	valley floor elev (see note)
61.4	Vs	resv vol at time of breach (acre-feet)
400	L	valley width at dam axis & w.s. elev (feet)
	ELwave	top of wave berm elevation
	Wwave	width of top of wave berm feet
	SSwave	wave berm side slope (SSwave:1)
	ELstab	top of stability berm elevation
	Wstab	width of top of stability berm (feet)
	SSstab	stability berm side slope (SSstab:1)
5	ts	timestep (minutes) for breach hydrograph

output		breach hydrograph	
variable	results	time (min)	Q (cfs)
T	373	0	0
(L < T)?	N	5	**1596**
H_w	12	10	1116
Q_1	6448	15	933
(H_w < 103)?	Y	20	780
Awave	0	25	652
Astab	0	30	545
A	576	35	456
Br	1	40	381
Q_2	1534	45	319
Q_{min}	1596	50	266
(Q_2 < Q_{min})?	Y	55	223
(Q_2 > Q_1)?	N	60	186
(Q_1 < Q_{min})?	N	65	156
Q_{max}	**1596**	70	130
		75	109
		80	91
		85	76



auto-scale hydrograph




breach hydrograph
discharge (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
15
30
45
60
75
90
105
120
135
150
time (minutes)

Attachment B

NRCS Unit Hydrograph Calculation

Unit Hydrograph Transformer

see comment version 3, Aug 2016 contact: dan.moore@por.usda.gov

input needed:

T_c = 1.4 time of concentration (hrs)
A = 0.07 drainage area (mi^2)
P_K = 484 peak rate factor (PRF, dimensionless)

calculate UH & S-curve

maxX=
maxY= 3200

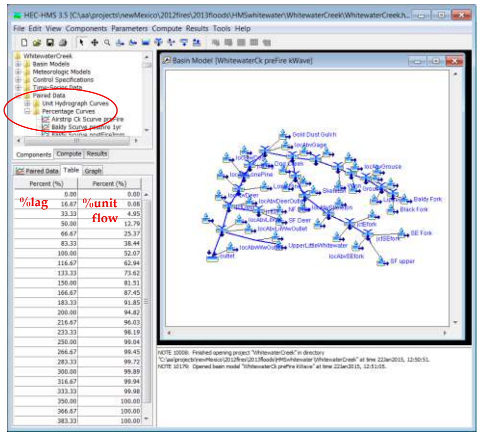
1.00

unit hydrograph: **S-curve:** **lag =** **0.840** (hrs)

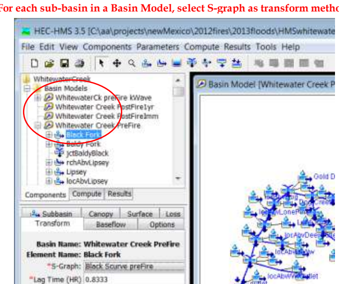
time (min)	discharge (CFS)	%lag	%unit flow
0	0	0.0	0.0
5	1.0	9.9	0.54
10	3.3	19.8	1.71
15	6.2	29.8	3.24
20	10.0	39.7	5.74
25	14.8	49.6	9.43
30	20.7	59.5	14.05
35	27.0	69.4	19.81
40	32.2	79.4	26.23
45	35.9	89.3	32.78
50	37.9	99.2	39.62
55	38.4	109.1	46.29
60	38.2	119.0	52.73
65	36.7	129.0	58.78
70	34.4	138.9	64.27
75	31.9	148.8	69.38
80	28.9	158.7	73.87
85	25.3	168.7	77.49
90	21.3	178.6	80.48
95	17.8	188.5	83.17
100	15.4	198.4	85.53
105	13.3	208.3	87.41
110	11.5	218.3	89.15
115	10.0	228.2	90.76
120	8.8	238.1	91.98
125	7.6	248.0	93.12
130	6.6	257.9	94.19
135	5.6	267.9	94.89
140	4.9	277.8	95.67
145	4.2	287.7	96.38
150	3.7	297.6	96.80
155	3.2	307.5	97.31
160	2.7	317.5	97.80
165	2.4	327.4	98.03
170	2.0	337.3	98.36
175	1.8	347.2	98.73
180	1.5	357.1	98.82
185	1.3	367.1	99.06
190	1.1	377.0	99.32
195	1.0	386.9	99.34
200	0.9	396.8	99.50
205	0.8	406.7	99.71
210	0.7	416.7	99.75
215	0.5	426.6	99.79
220	0.5	436.5	100.00
225	0.4		
230	0.4		
235	0.3		
240	0.3		
245	0.2		
250	0.2		
255	0.2		
260	0.1		
265	0.1		
270	0.1		
275	0.0		
280			
285			
290			
295			
300			
305			
310			
315			
320			
325			
330			
335			
340			
345			
350			
355			
360			
365			
370			
375			
380			
385			
390			
395			
400			
405			
410			
415			
420			
425			
430			
435			
440			
445			
450			
455			

To use in HecHMS:

Store all the S curves in Paired Data (one for each sub-basin):



For each sub-basin in a Basin Model, select S-graph as transform method, then connect to paired data:



for each sub-basin, connect to a curve in Paired Data. Get Lag Time in Cell E11

equations used:

$$\Delta D = 0.133 T_c$$ NEH 630 16A-13

$$L = 0.6 T_c$$ NEH 630 15-3

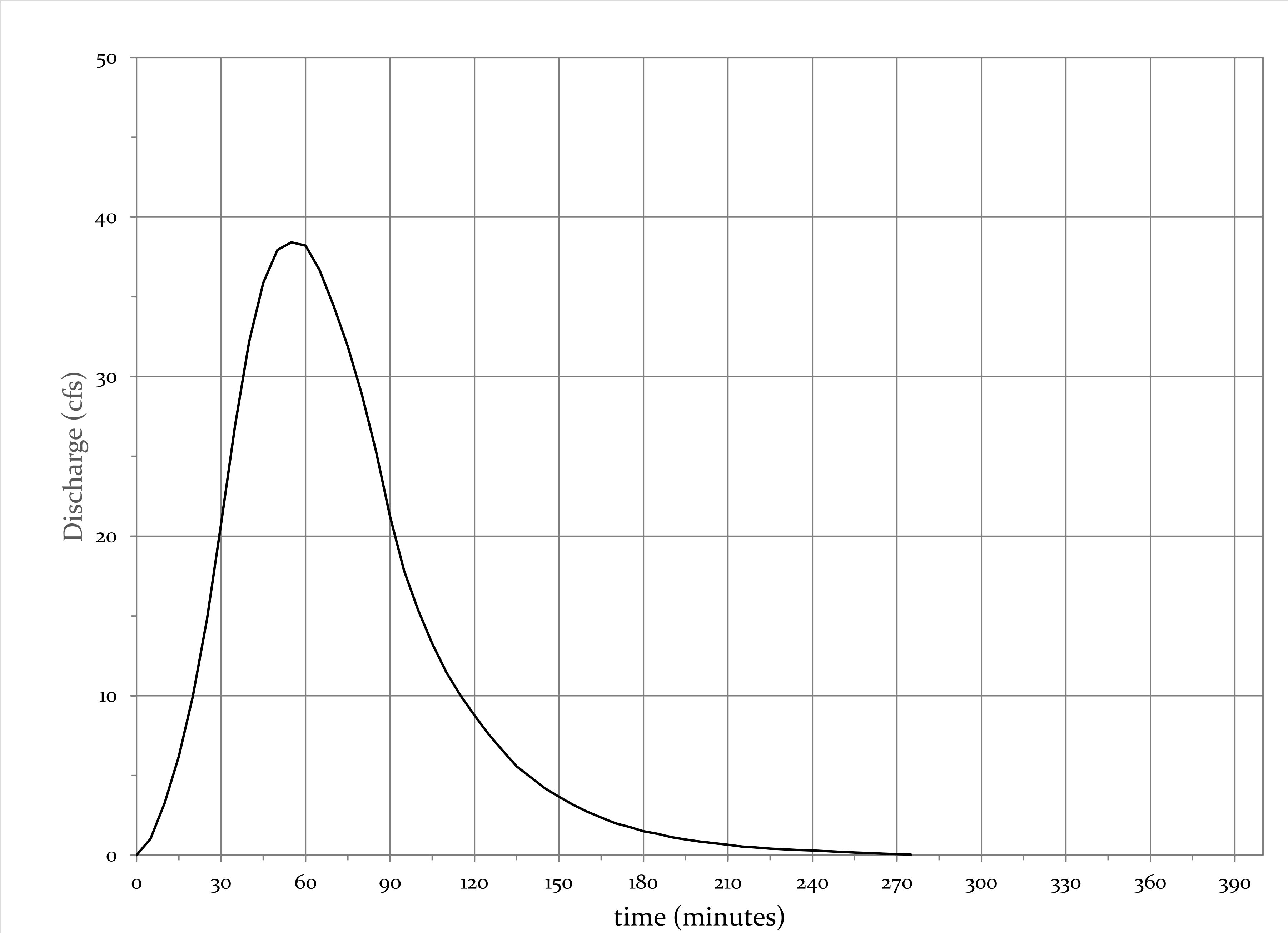
$$T_p = \frac{\Delta D}{2} + L$$ NEH 630 16A-7

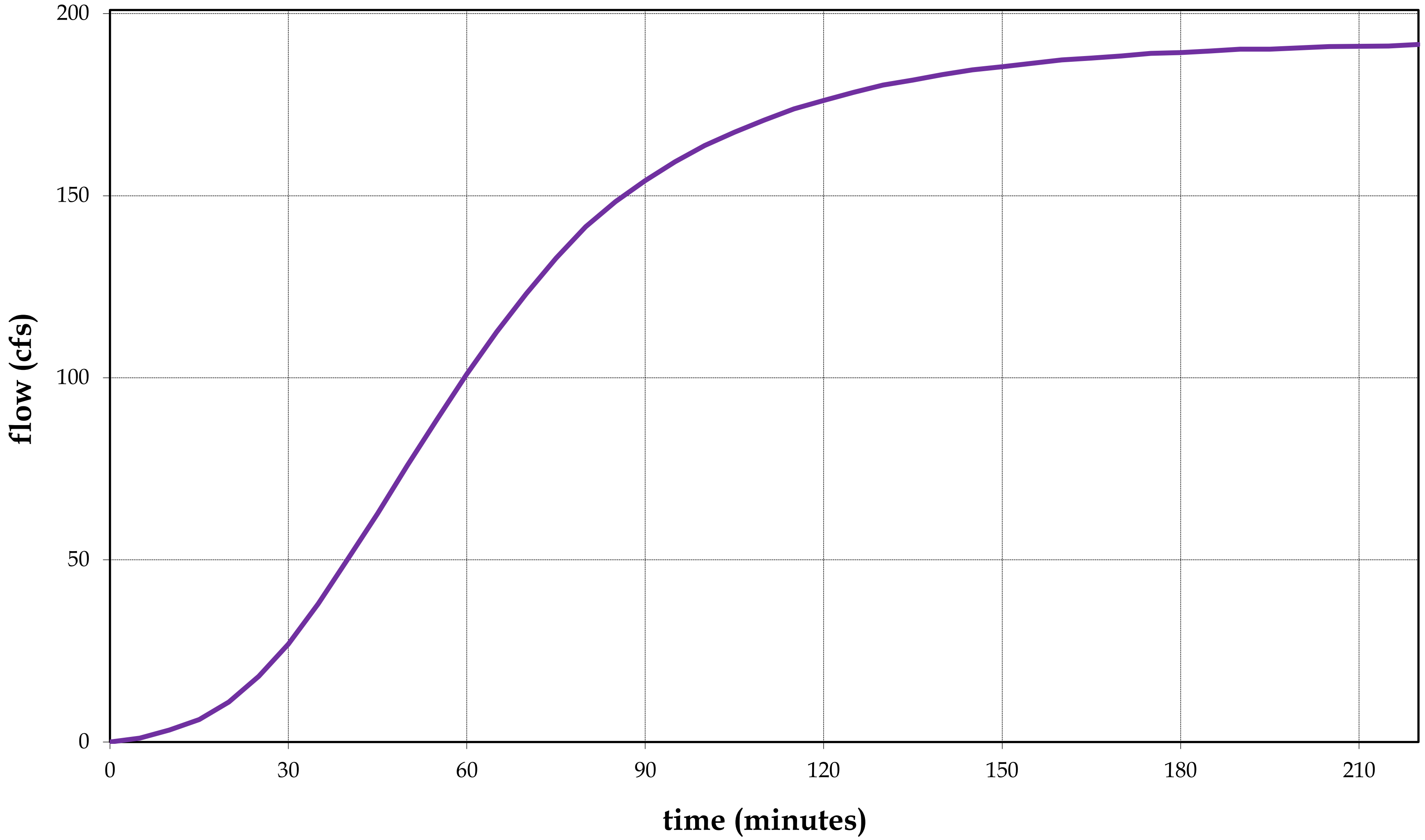
$$q_p = \frac{P_k A Q}{T_p}$$ NEH 630 16A-6
Q is one inch

gamma equation:

$$\frac{q}{q_p} = e^m * \left(\frac{t}{t_p}\right)^m * e^{\left(-m\frac{t}{t_p}\right)}$$ NEH 630 16-1

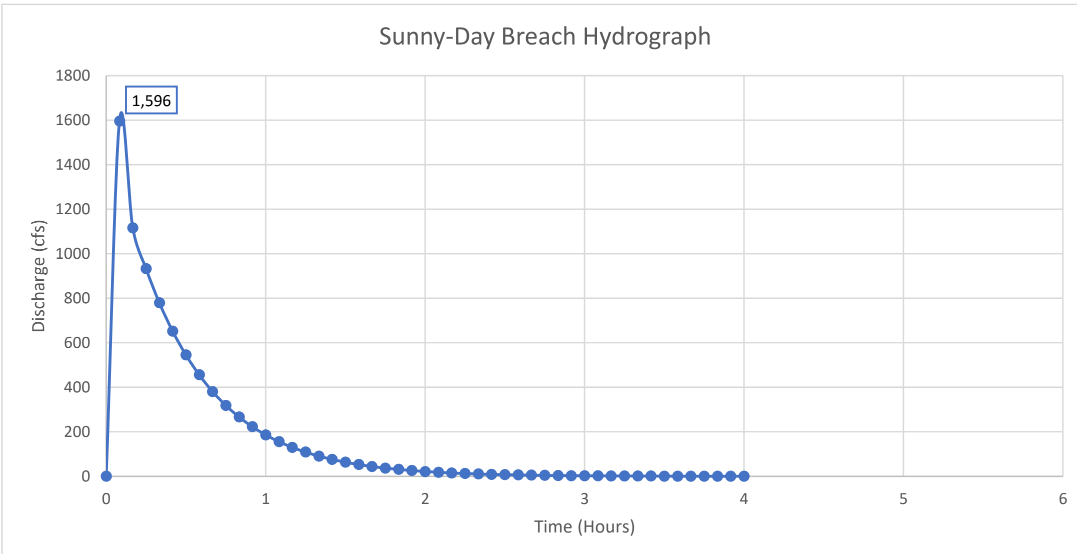
$$PRF = \frac{645.33}{timestep * \sum \frac{q}{q_p}}$$ NEH 630 16A-2


50
40
30
20
10
0
Discharge (cfs)
0
30
60
90
120
150
180
210
240
270
300
330
360
390
time (minutes)

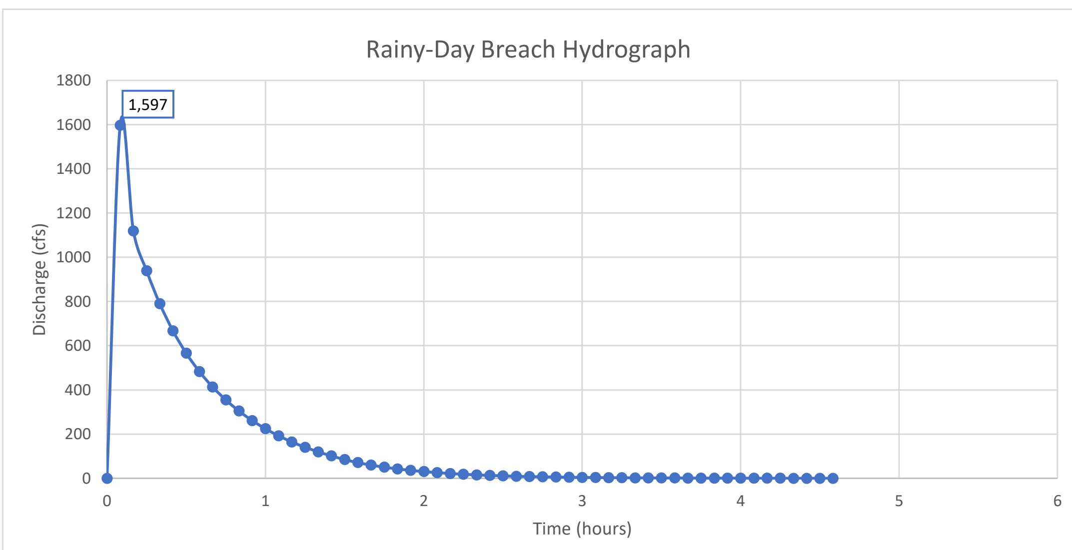

flow (cfs)
200
150
100
50
0
0
30
60
90
120
150
180
210
time (minutes)

Attachment C

DSS-WISE Lite Input Hydrographs



Note: This hydrograph is just the breach hydrograph calculated by the NRCS spreadsheet.



Note: This hydrograph is the addition of the NRCS calculated unit hydrograph and breach hydrograph.

Attachment D

Sunny-Day Simulation Report

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ Lite
Flood Simulation Report

Hydrograph-type, sudden and complete br each

Sunny Day Breach - Old Duck Pond

NAXXXXX

February 22, 2024

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

FOR OFFICIAL USE ONLY

Table of Contents

1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
`https://dsswiseweb.ncche.olemiss.edu`

Disclaimer

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Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Sunny Day Breach - Old Duck Pond
Scenario Name:	Hydrograph-type, sudden and complete br each
NIDID:	NAXXXXX
Scenario Description:	1 active reservoir 1 active impounding structure hydrograph-type, sudden and c omplete breach of Dam 1
User e-mail:	ahaneke@haleyaldrich.com
Group:	MASSACHUSETTS

2.2 Simulation Parameters

Domain buffer distance (miles):	10
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	5

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Dam 1
Structure Type:	Embankment
Hydraulic Height (ft):	12.0
Crest Elevation (ft):	1144.26
Length (ft):	370.813156292

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 User-Drawn Levees

Number of User-Drawn Levees: 0

2.6 User-Specified Breach Hydrograph

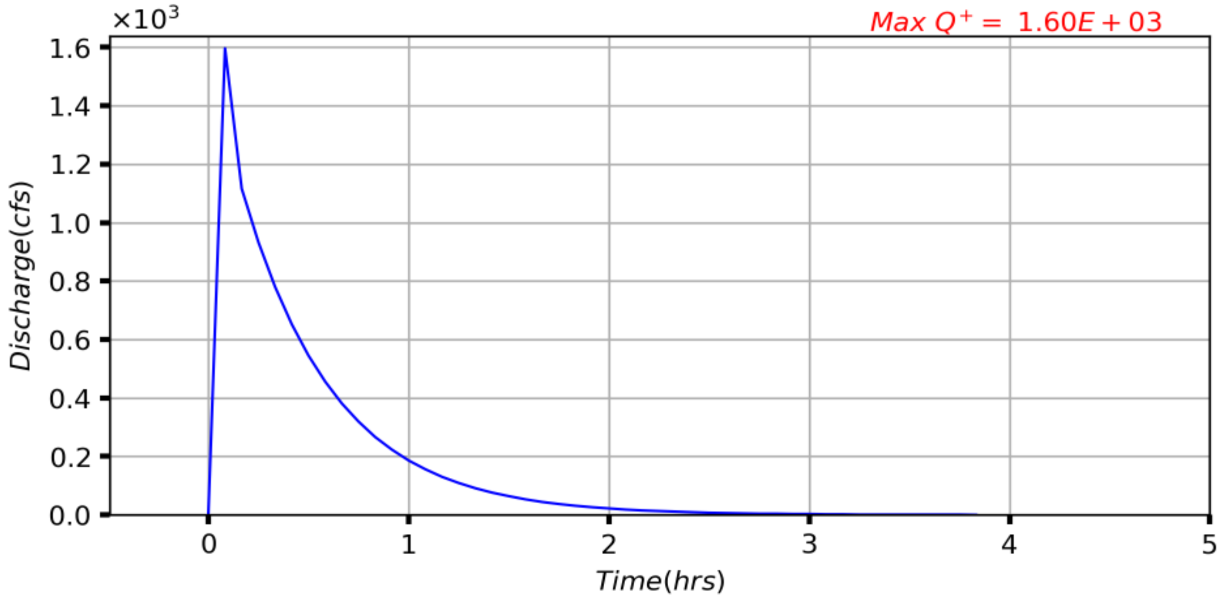

Figure 1. Breach inflow hydrograph for: Dam 1.

2.7 Reservoir Characteristics

Number of Reservoirs: 1

Reservoir Name:	Reservoir 1
Selected Reservoir Point (Latitude/Longitude):	42.5977287693/-71.9841222979
Pool Elevation @ Max Storage (ft):	1145.76
Maximum Storage Volume (ac-ft):	61.4
Pool Elevation @ Normal Storage (ft):	1144.26
Normal Storage Volume (ac-ft):	26.6
Pool Elevation @ Failure (ft):	1145.76
Failure Storage Volume (ac-ft):	61.4

2.8 Failure Conditions

Structure Name:	Dam 1
Structure Type:	Embankment
Failure Mode:	Total Dam Breach
Breach Location (Latitude/Longitude):	42.5978205568/-71.984286

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.

2. Burn U.S. Army Corps of Engineers (USACE) levee lines and group-specific levee lines (if any) within the AOI, as well as any user-drawn levees into the DEM.

3. Assign Manning's coefficients based on LULC classifications.

4. Validate user provided simulation input parameters.

5. Remove user identified bridges from the DEM.

6. Estimate reservoir bathymetry.

7. Extend impounding structures if the specified reservoir level cannot be contained.

8. Fill reservoir to specified failure elevation.

9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

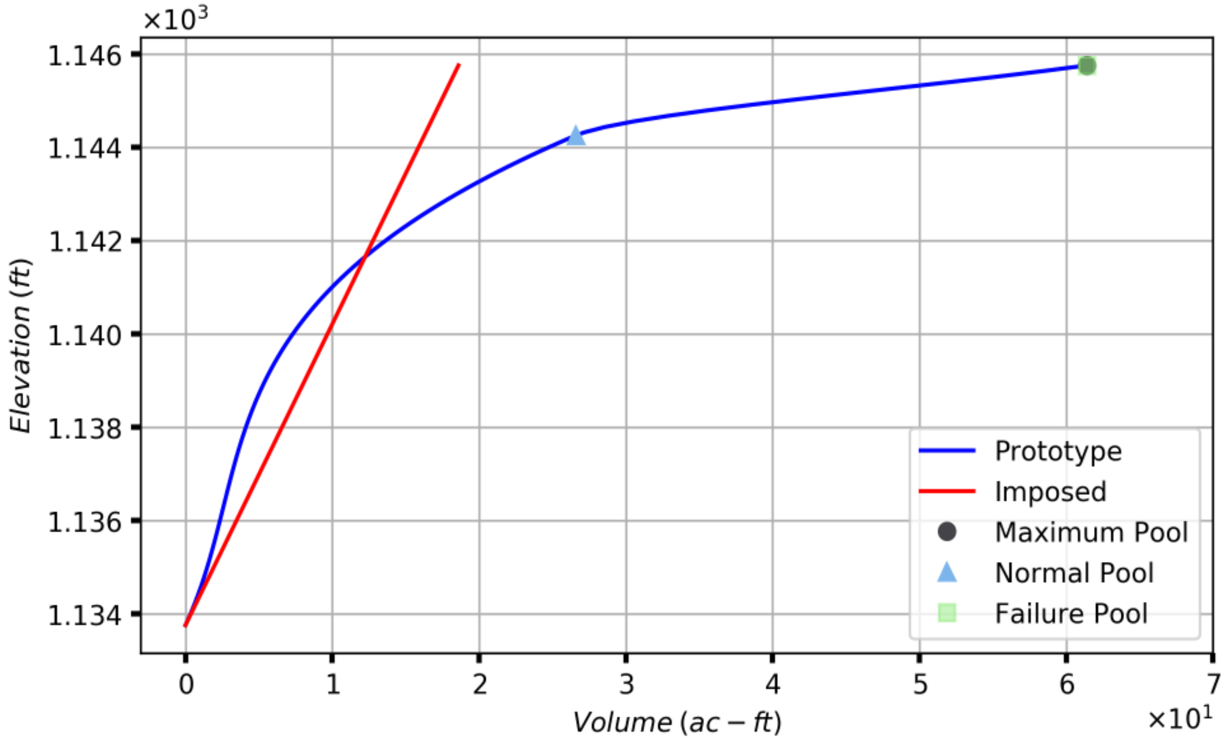

Figure 2. Stage-Volume Curve for Reservoir: Reservoir 1.

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.
Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.
User-given Storage Volume at Failure (ac-ft): 61.4
Imposed Storage Volume at Failure (ac-ft): 18.6
After filling to the failure elevation, the imposed reservoir volume matched 30.3% of the prototype volume.

Extended Structures:
Dam 1 has been extended to contain the reservoir.

3.3 Data Sources

1. Digital Elevation Models

   Sources: USGS 3D Elevation Program (3DEP) 2019 datasets, NOAA, and any group-specific DEM data if provided

   Resolutions: 2, 1, 1/3, and 1/9th arc-second, 1 meter, and varying resolutions of group-specific DEM data (if any), based upon availability

   Vertical Datum: NAVD88

   Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

   Sources: USGS 2016 (CONUS), 2011 (Alaska), and 2001 (Hawaii and Puerto Rico)

   Resolution: 30 m

3. National Levee Database

   Source: USACE

4. Group-specific levee data

   Source: Provided by individual groups

3.4 Digital Elevation Model

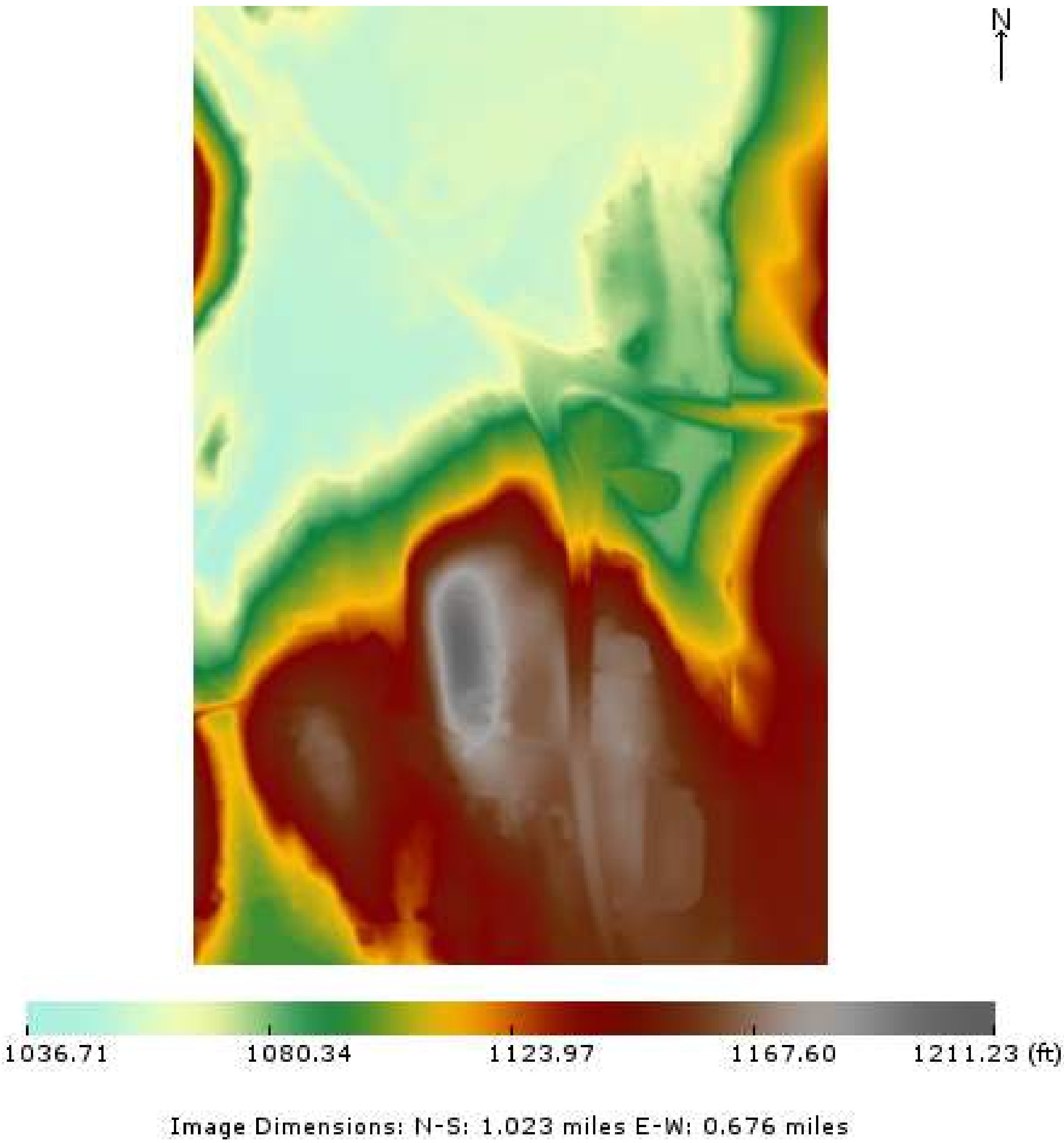

Figure 3. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

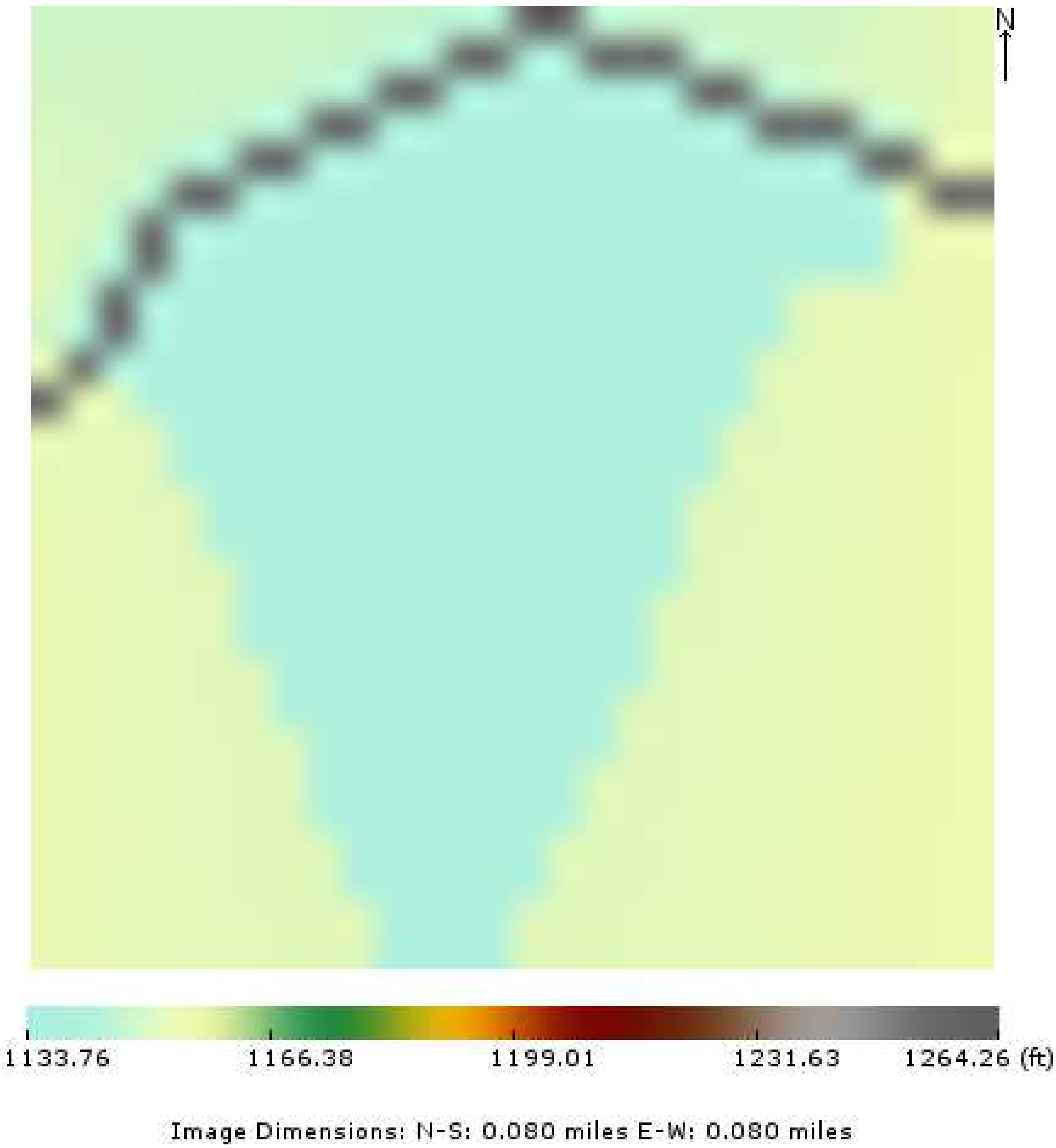

Figure 4. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

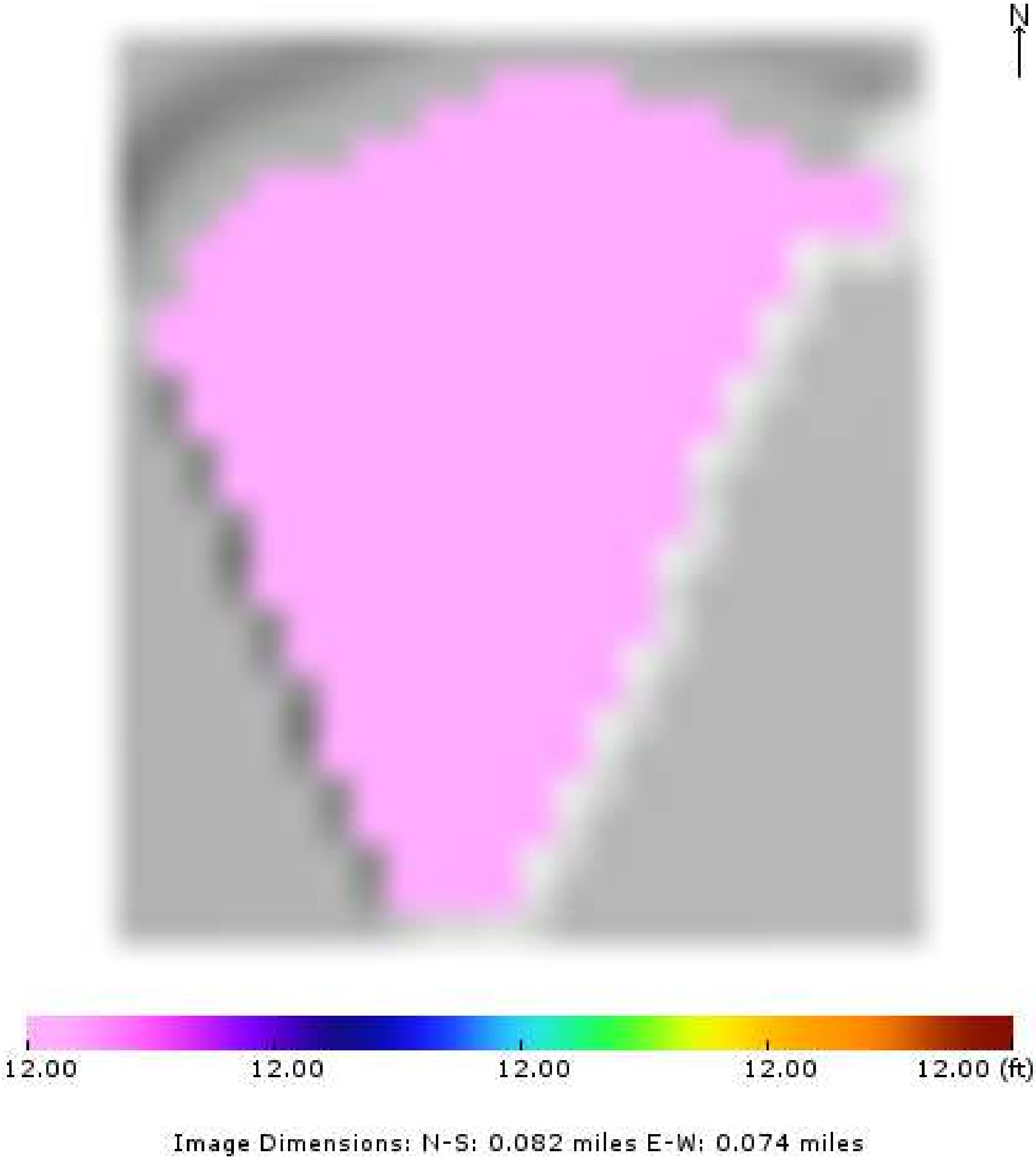

Figure 5. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover

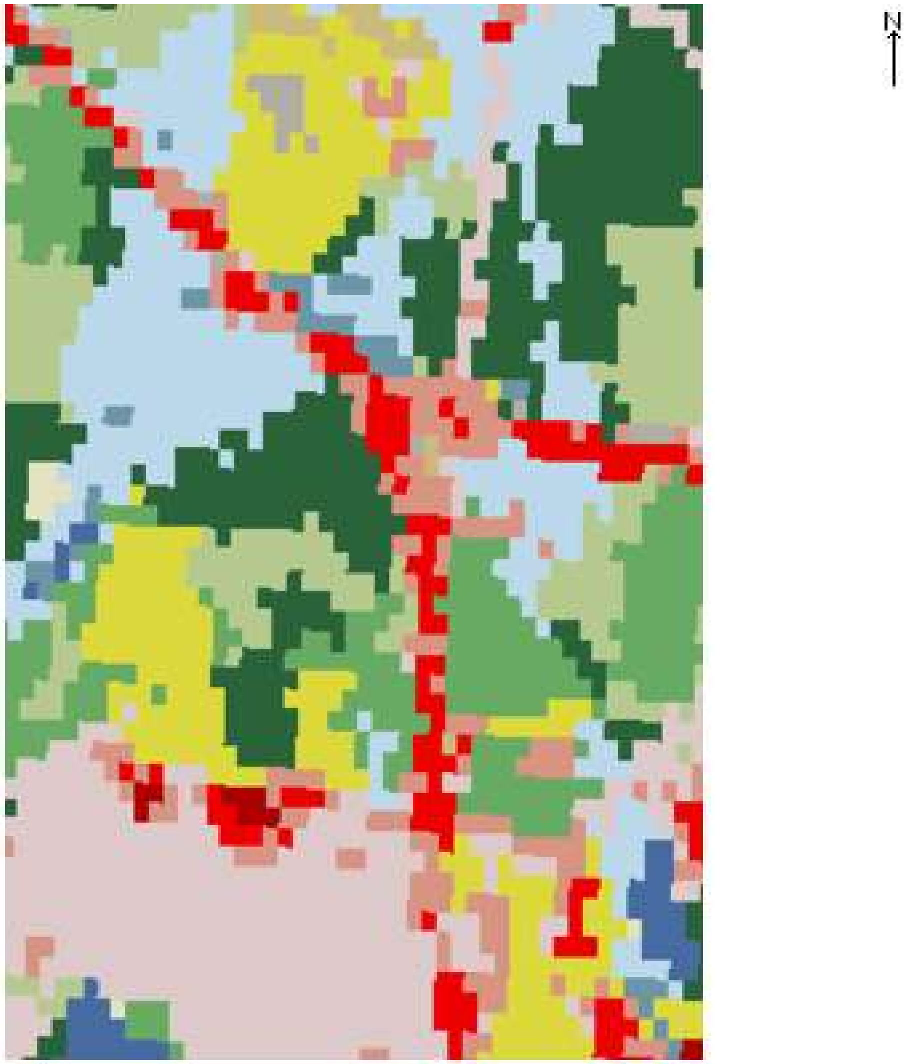

Image Dimensions: N-S: 1.023 miles E-W: 0.676 miles

Figure 6. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	10:43 AM CST (02/22/2024)
Simulation Start Time:	10:44 AM CST (02/22/2024)
Simulation End Time:	10:45 AM CST (02/22/2024)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	0.9
Domain buffer distance (miles):	10
Elapsed simulation time after breach initiation (hrs):	11.3
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Woody Wetlands	45.16	0.1500	90	
Developed, Low Density	9.47	0.0678	22	
Hay/Pasture	8.99	0.0350	81	
Evergreen Forest *	7.56	0.1000	42	
Emergent Herbaceous Wetlands	7.35	0.1825	95	
Developed, Open Space	5.69	0.0404	21	
Open Water	5.04	0.0330	11	
Developed, Medium Density	4.67	0.0678	23	
Mixed Forest *	3.21	0.1200	43	
Deciduous Forest *	2.27	0.1000	41	
Barren Land	0.28	0.0113	31	
Grassland/Herbaceous	0.24	0.0400	71	
Unclassified	0.00	0.0350	0	
Perennial Snow/Ice	0.00	0.0100	12	
Developed, High Density	0.00	0.0404	24	
Dwarf Scrub *	0.00	0.0350	51	
Shrub/Scrub	0.00	0.0400	52	
Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	
Cultivated Crops	0.00	0.0700	82	

Note: * indicates an n-value estimated by NCCHE. ** indicates an n-value given by the user. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets

Figure 7. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	
USGS	1 meter	usgs_utm_z19_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

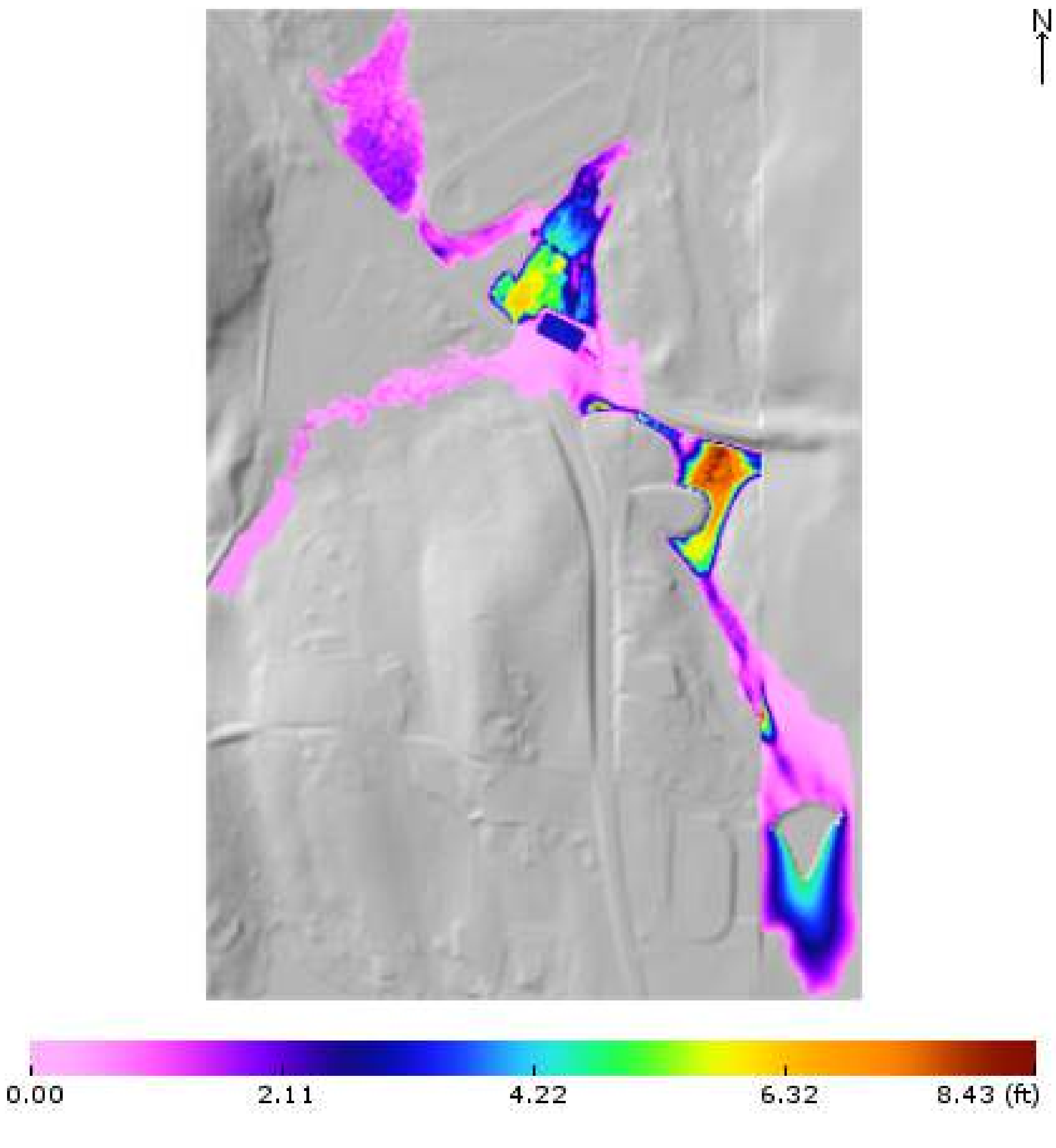

Figure 8. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

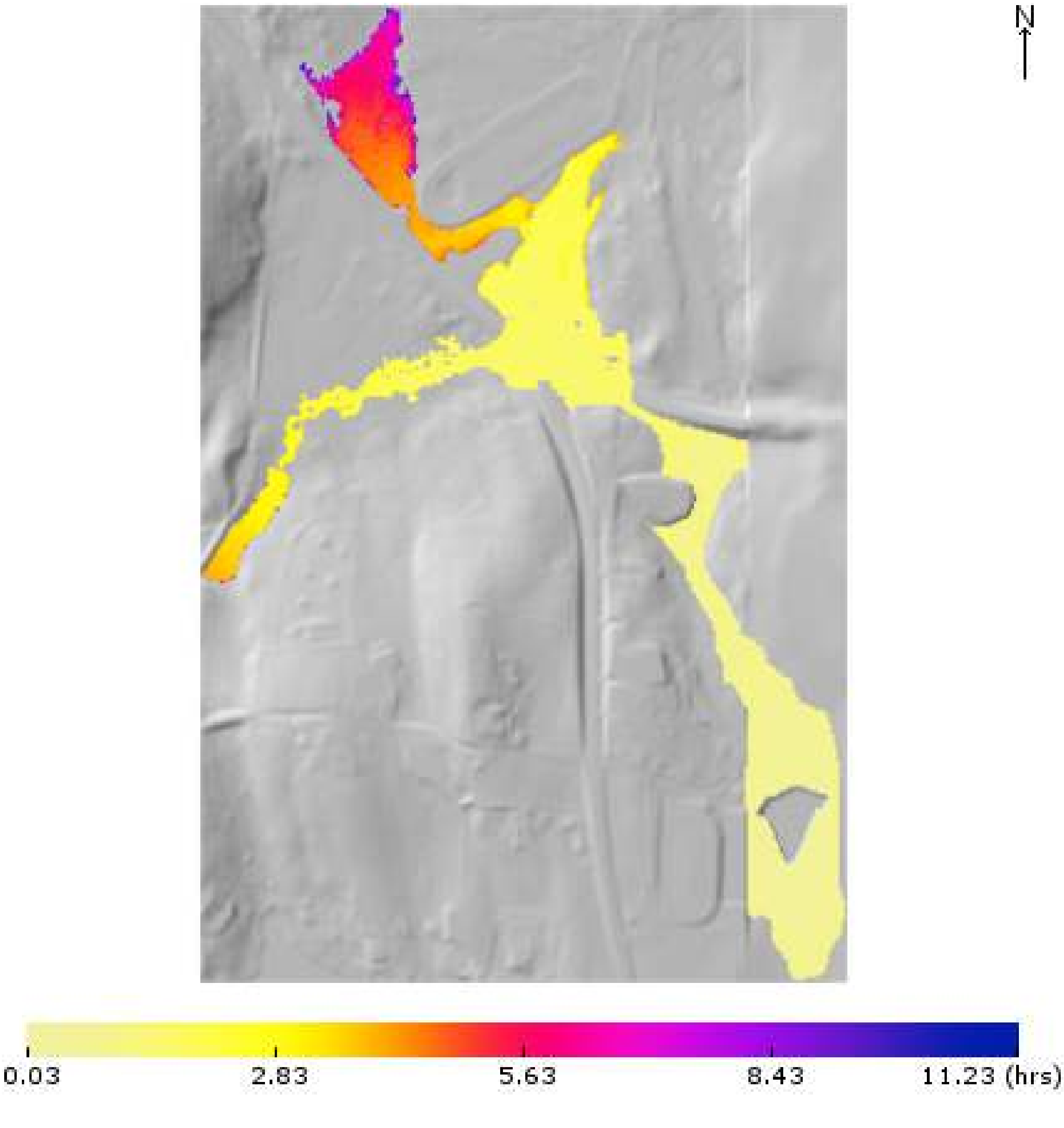

Figure 9. Flood Arrival Time Map.

4.6 Downloading Simulation Results

The simulation results can be accessed at the following web address:

`https://dsswiseweb.ncche.olemiss.edu/download`

Job ID: 74035

Attachment E

Rainy-Day Simulation Report

FEMA

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ Lite Flood Simulation Report

Hydrograph-type, sudden and complete br each

Rainy Day Breach - Old Duck Pond

NAXXXXX

February 22, 2024

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

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Table of Contents

1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
`https://dsswiseweb.ncche.olemiss.edu`

Disclaimer

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Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Rainy Day Breach - Old Duck Pond
Scenario Name:	Hydrograph-type, sudden and complete br each
NIDID:	NAXXXXX
Scenario Description:	1 active reservoir 1 active impounding structure hydrograph-type, sudden and c omplete breach of Dam 1
User e-mail:	ahaneke@haleyaldrich.com
Group:	MASSACHUSETTS

2.2 Simulation Parameters

Domain buffer distance (miles):	10
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	5

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Dam 1
Structure Type:	Embankment
Hydraulic Height (ft):	12.0
Crest Elevation (ft):	1144.26
Length (ft):	370.813156292

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 User-Drawn Levees

Number of User-Drawn Levees: 0

2.6 User-Specified Breach Hydrograph

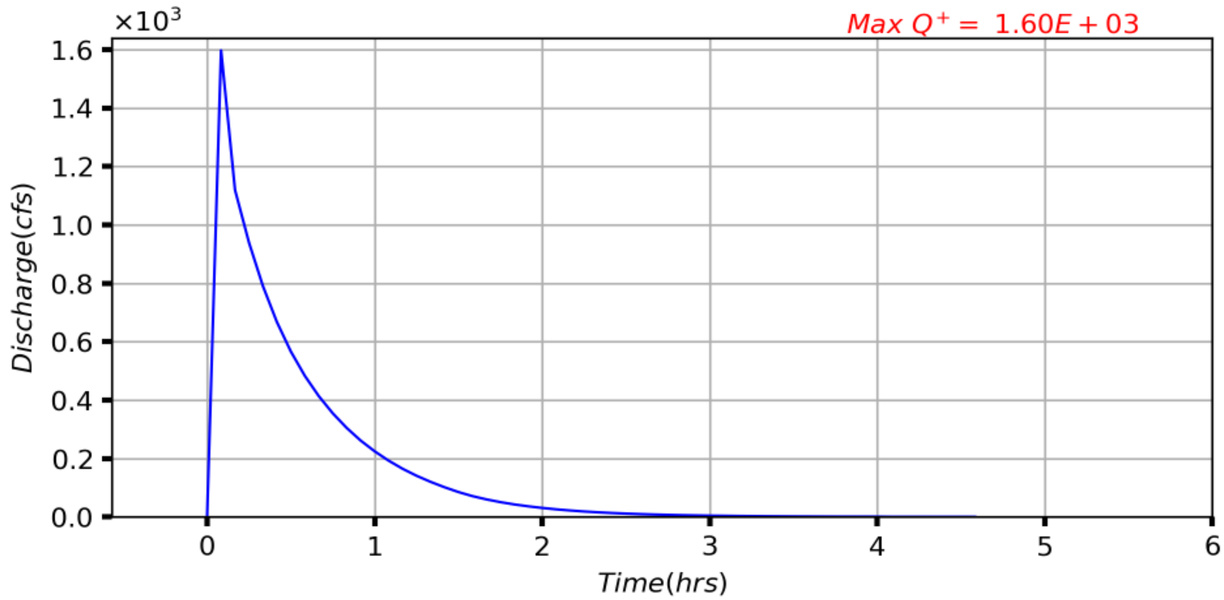


Figure 1. Breach inflow hydrograph for: Dam 1.

2.7 Reservoir Characteristics

Number of Reservoirs: 1

Reservoir Name:	Reservoir 1
Selected Reservoir Point (Latitude/Longitude):	42.5977287693/-71.9841222979
Pool Elevation @ Max Storage (ft):	1145.76
Maximum Storage Volume (ac-ft):	61.4
Pool Elevation @ Normal Storage (ft):	1144.26
Normal Storage Volume (ac-ft):	26.6
Pool Elevation @ Failure (ft):	1145.76
Failure Storage Volume (ac-ft):	61.4

2.8 Failure Conditions

Structure Name:	Dam 1
Structure Type:	Embankment
Failure Mode:	Total Dam Breach
Breach Location (Latitude/Longitude):	42.5978205568/-71.984286

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.
2. Burn U.S. Army Corps of Engineers (USACE) levee lines and group-specific levee lines (if any) within the AOI, as well as any user-drawn levees into the DEM.
3. Assign Manning's coefficients based on LULC classifications.
4. Validate user provided simulation input parameters.
5. Remove user identified bridges from the DEM.
6. Estimate reservoir bathymetry.
7. Extend impounding structures if the specified reservoir level cannot be contained.
8. Fill reservoir to specified failure elevation.
9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

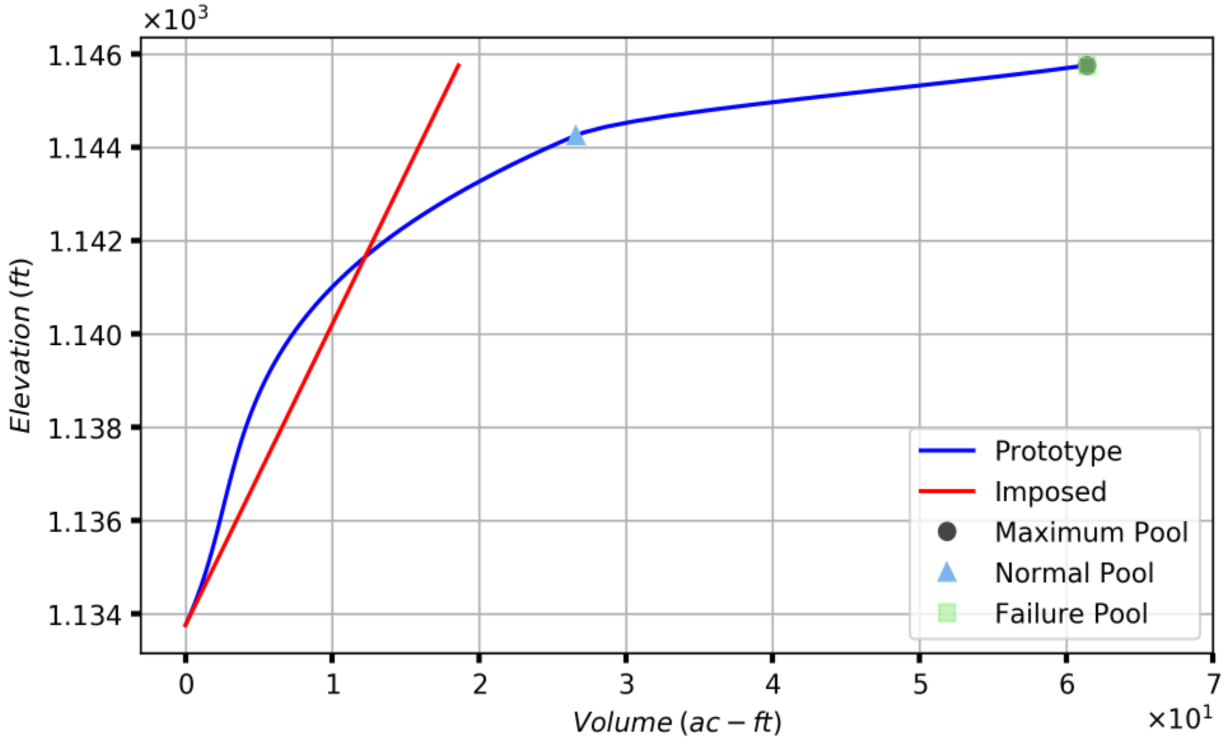


Figure 2. Stage-Volume Curve for Reservoir: Reservoir 1.

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.
Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.
User-given Storage Volume at Failure (ac-ft): 61.4
Imposed Storage Volume at Failure (ac-ft): 18.6
After filling to the failure elevation, the imposed reservoir volume matched 30.3% of the prototype volume.

Extended Structures:
Dam 1 has been extended to contain the reservoir.

3.3 Data Sources

1. Digital Elevation Models

   Sources: USGS 3D Elevation Program (3DEP) 2019 datasets, NOAA, and any group-specific DEM data if provided

   Resolutions: 2, 1, 1/3, and 1/9th arc-second, 1 meter, and varying resolutions of group-specific DEM data (if any), based upon availability

   Vertical Datum: NAVD88

   Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

   Sources: USGS 2016 (CONUS), 2011 (Alaska), and 2001 (Hawaii and Puerto Rico)

   Resolution: 30 m

3. National Levee Database

   Source: USACE

4. Group-specific levee data

   Source: Provided by individual groups

3.4 Digital Elevation Model

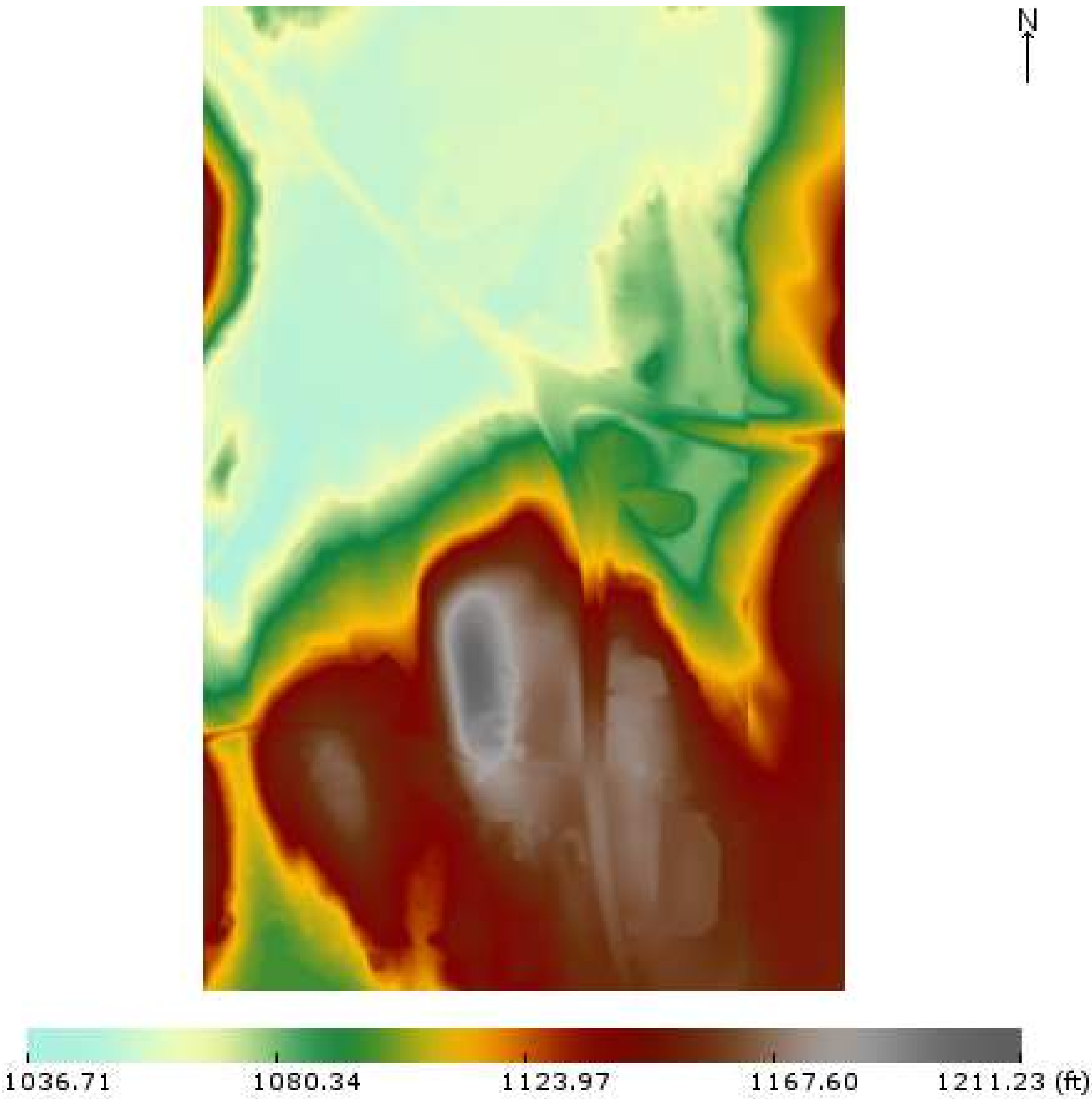


Figure 3. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

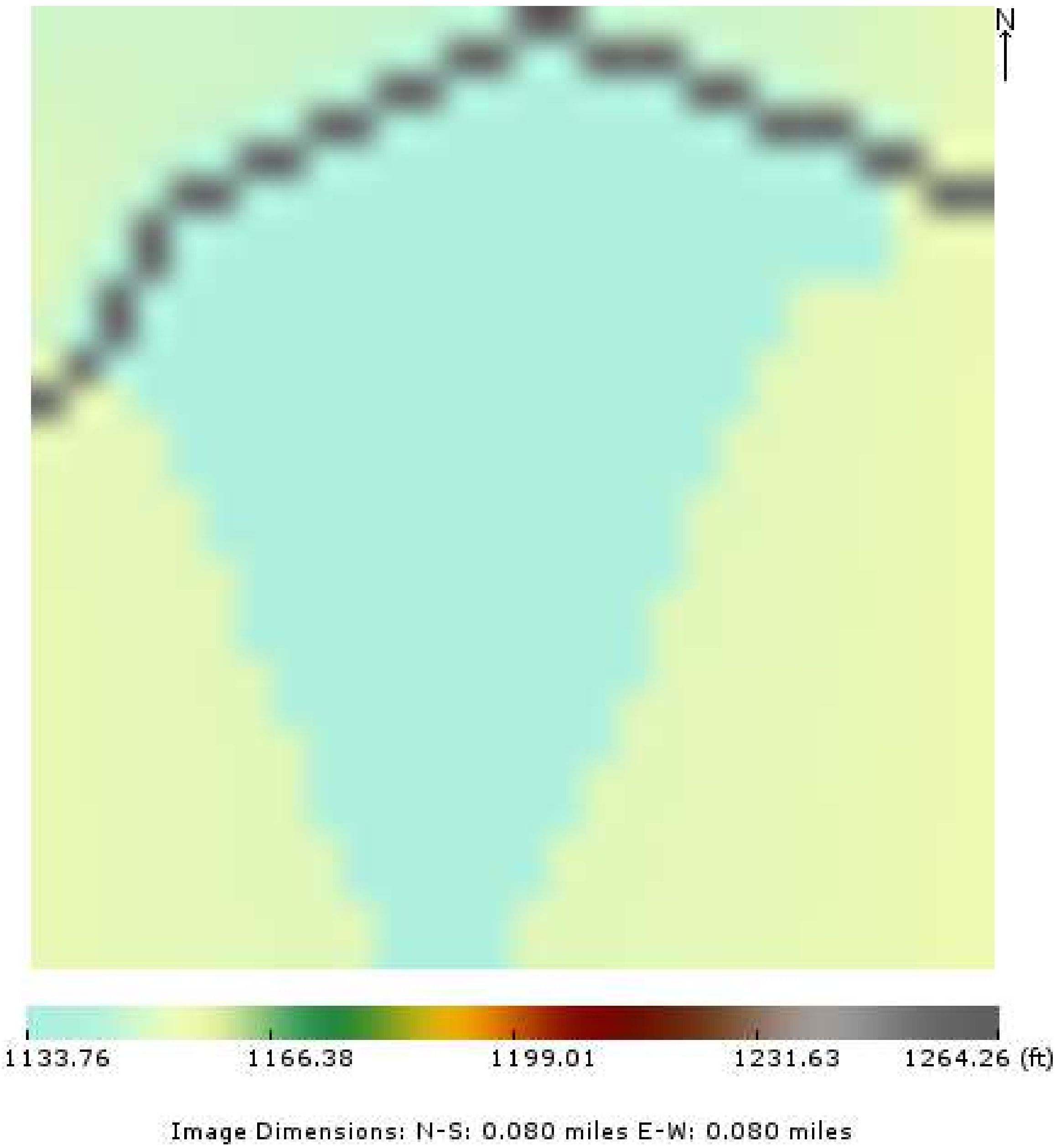


Figure 4. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

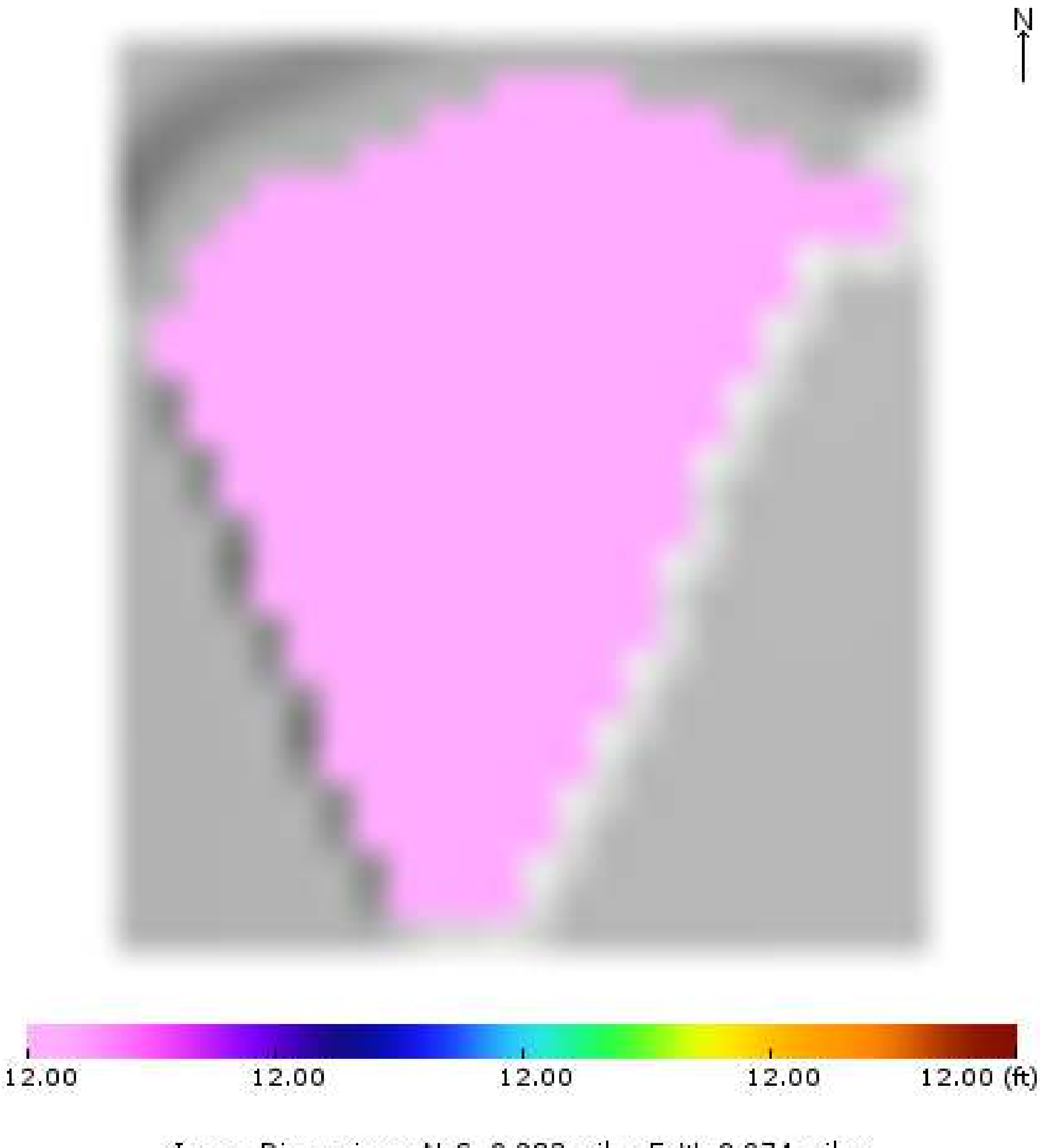


Figure 5. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover

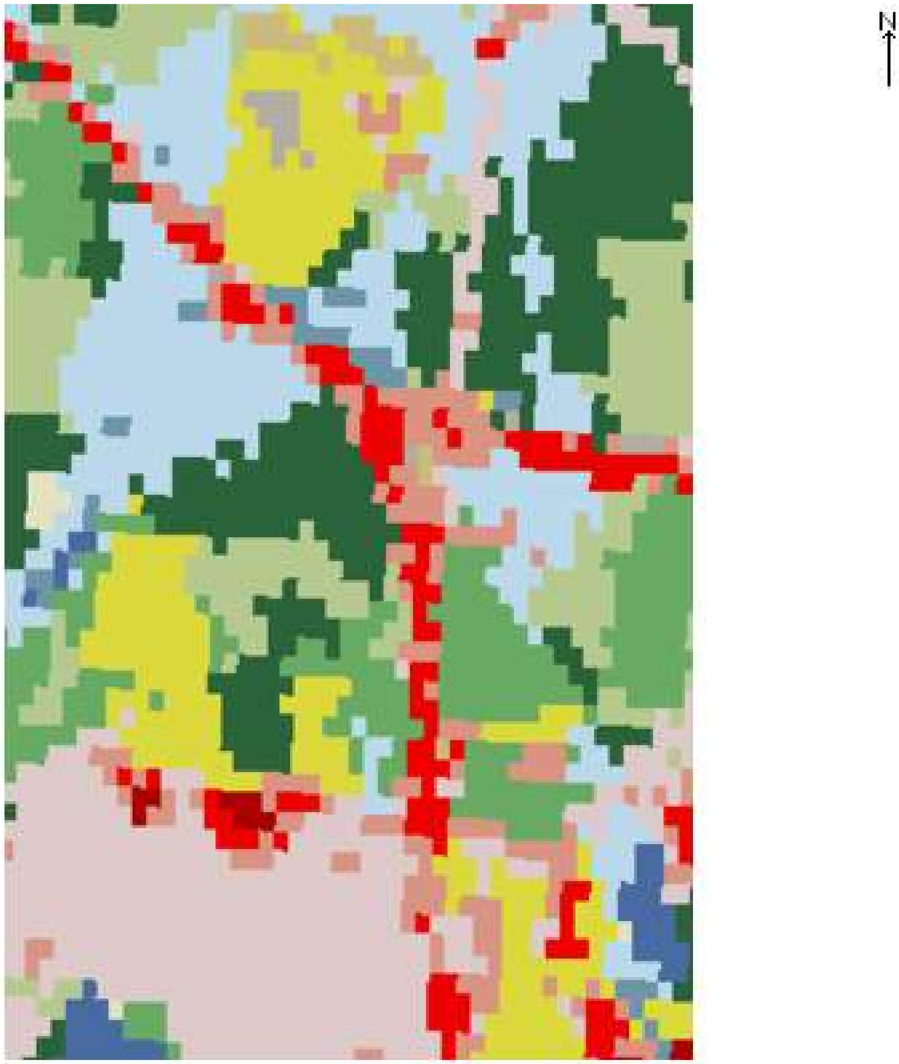


Image Dimensions: N-S: 1.040 miles E-W: 0.676 miles

Figure 6. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	11:08 AM CST (02/22/2024)
Simulation Start Time:	11:09 AM CST (02/22/2024)
Simulation End Time:	11:11 AM CST (02/22/2024)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	0.9
Domain buffer distance (miles):	10
Elapsed simulation time after breach initiation (hrs):	11.4
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Woody Wetlands	45.42	0.1500	90	
Developed, Low Density	9.26	0.0678	22	
Hay/Pasture	9.22	0.0350	81	
Evergreen Forest *	7.48	0.1000	42	
Emergent Herbaceous Wetlands	7.20	0.1825	95	
Developed, Open Space	5.59	0.0404	21	
Open Water	4.89	0.0330	11	
Developed, Medium Density	4.60	0.0678	23	
Mixed Forest *	3.52	0.1200	43	
Deciduous Forest *	2.24	0.1000	41	
Barren Land	0.27	0.0113	31	
Grassland/Herbaceous	0.23	0.0400	71	
Unclassified	0.00	0.0350	0	
Perennial Snow/Ice	0.00	0.0100	12	
Developed, High Density	0.00	0.0404	24	
Dwarf Scrub *	0.00	0.0350	51	
Shrub/Scrub	0.00	0.0400	52	
Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	
Cultivated Crops	0.00	0.0700	82	

Note: * indicates an n-value estimated by NCCHE. ** indicates an n-value given by the user. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets

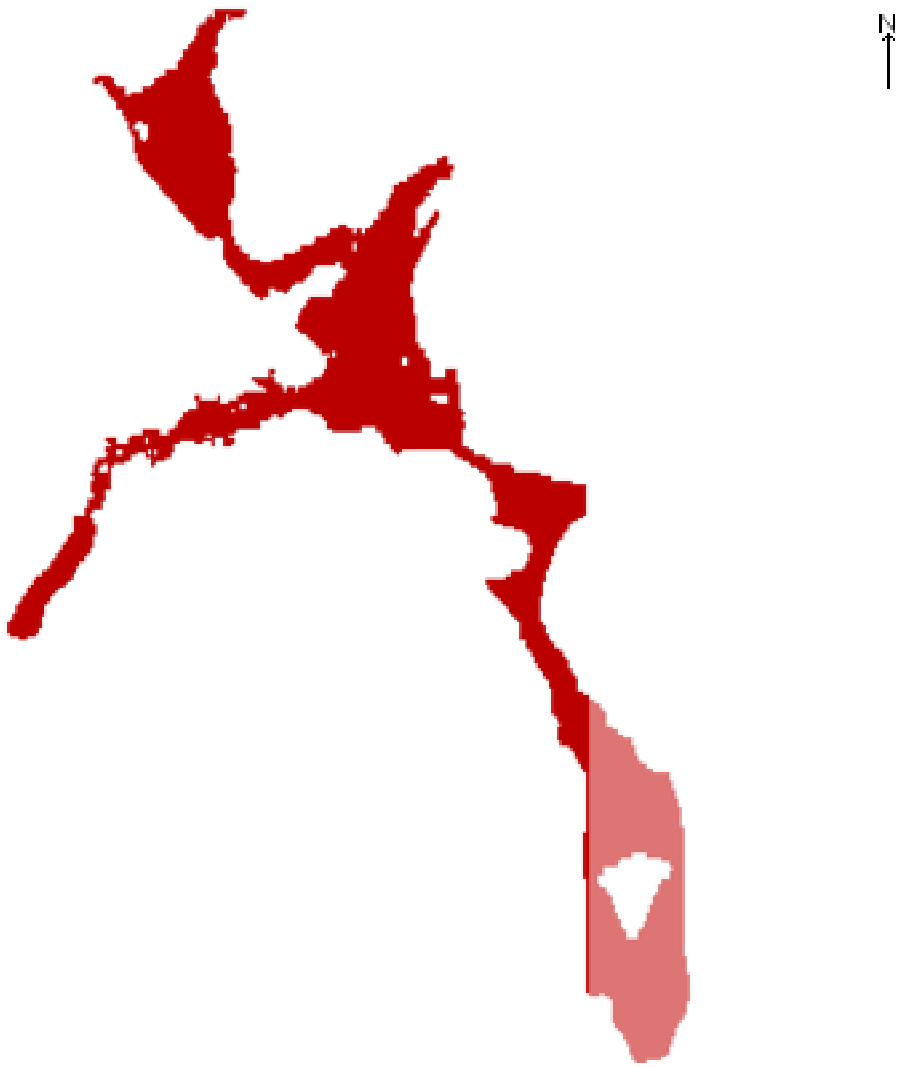


Figure 7. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	
USGS	1 meter	usgs_utm_z19_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

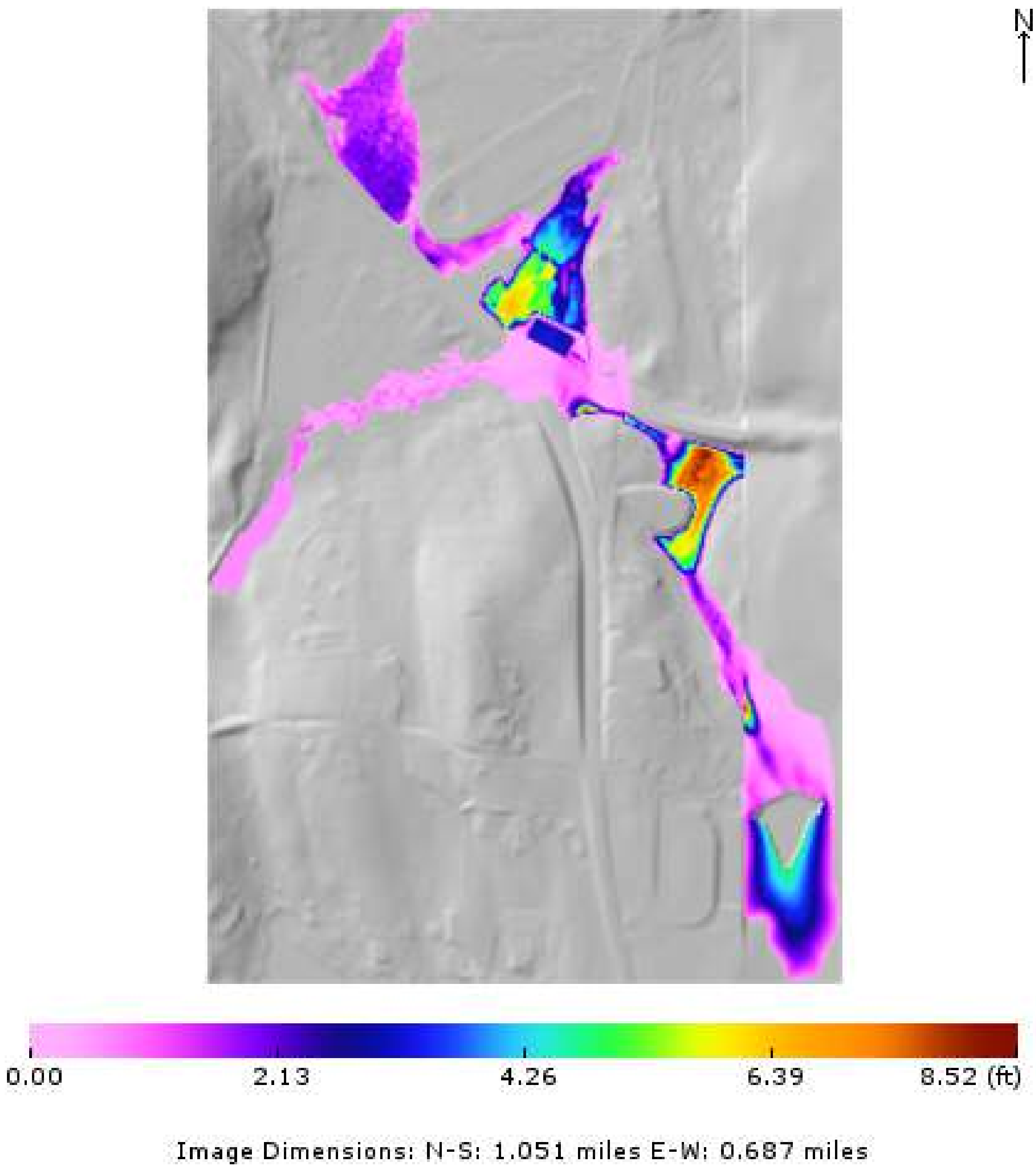


Figure 8. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

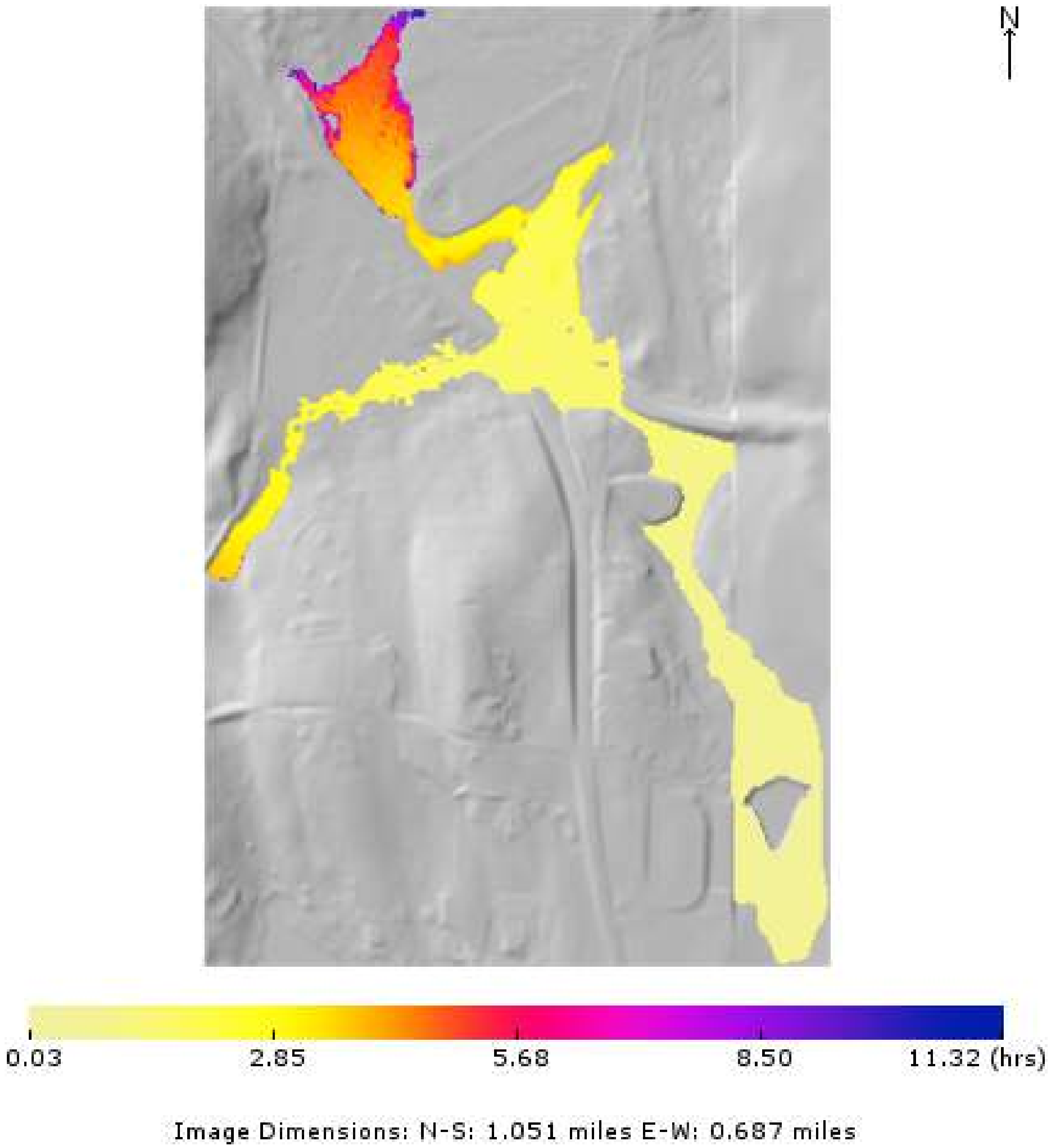


Figure 9. Flood Arrival Time Map.

4.6 Downloading Simulation Results

The simulation results can be accessed at the following web address:

`https://dsswiseweb.ncche.olemiss.edu/download`

Job ID: 74036

HALEY ALDRICH	CALCULATIONS	File No.	29913-028
		Sheet	1 of 1
Client	Mount Wachusett Community College	Date	31-Jan-25
Project	Old Duck pond Dam Breach	Computed by	DJB
Subject	Hydraulic and Hydrologic Analysis	Checked by	

Hydraulic and Hydrologic Analysis

The following hydraulic and hydrologic analysis is based on a breach of Old Duck Pond Dam and installing a 6 ft wide by 4 ft high culvert with an invert at El. 1140. The below rainstorms and associated peak flows were determined using the computer program StreamStats developed and published by the USGS. The developed flows were calibrated using outputs from the application DSS-WISE Lite supported by FEMA and the unit hydrograph developed in accordance with the Natural Resources Conservation Service (NRCS) Unit Hydrograph webpage and UHtransformerVer3, dated August 2016.

Watershed Data
Total Drainage Area = 0.08 sq. mi.
Ponds and swamp areas = 7.4%
Forested Area = 46%
Average Slope = 5%
Drainage Length = 3,200 ft

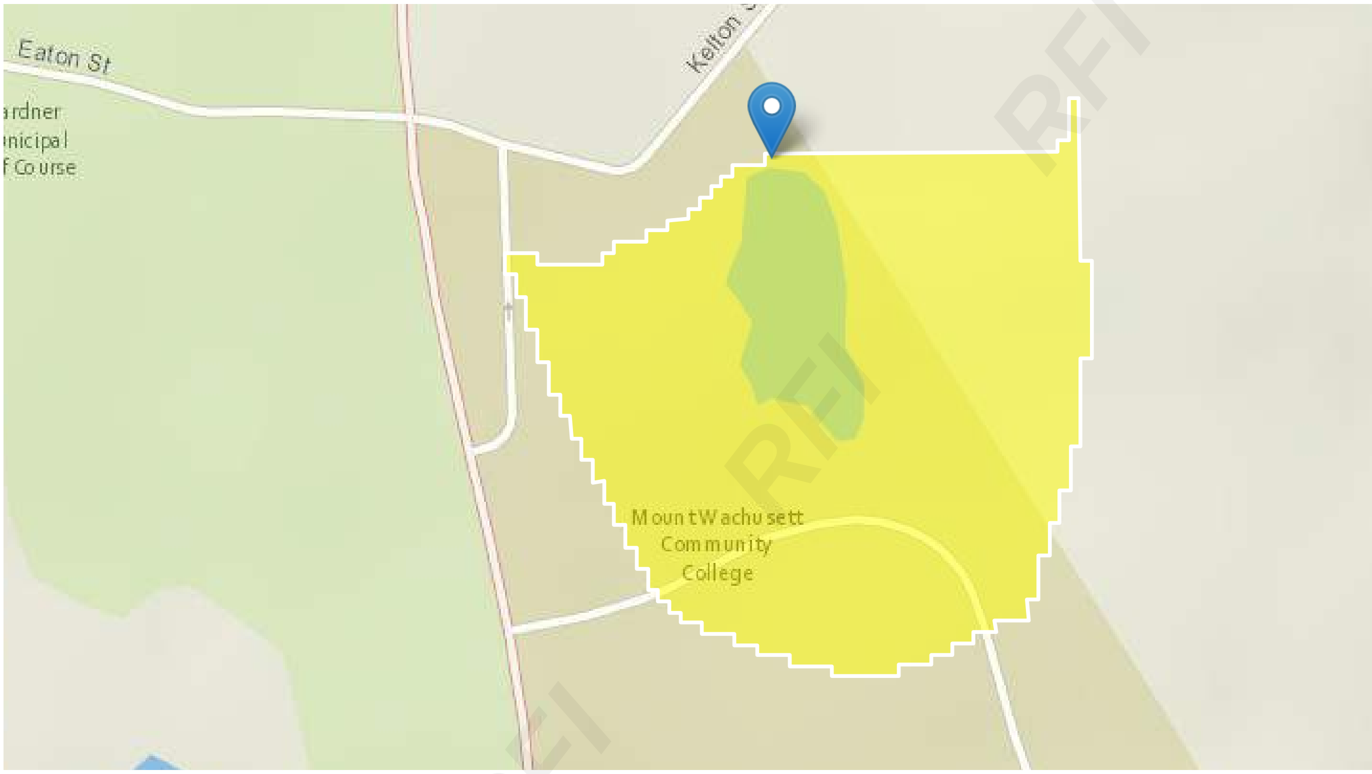
Proposed Design Water Elevation for Dam Breach

Design Storm Event Annual Exceedance Probability (%, AEP)	Return Period (YR)	Peak Flow (CFS)	Pond EL. (FT)	Water Depth Above El. 1140 Normal Pool. (FT)
--	0	0	1140.0	0.0
50	2	7.1	1140.5	0.5
20	5	12.7	1140.8	0.8
10	10	17.6	1141.0	1.0
4	25	25.1	1141.2	1.2
2	50	31.5	1141.5	1.5
1	100	38.6 (38.4)	1141.7	1.7
0.5	200	46.5	1141.9	1.9
0.2	500	58.4	1142.2	2.2

Note: Results from StreamStats were calibrated for the 1% annual exceedance probability flood using WS-WISE LITE.

Old Duck Pond Dam Breach

Region ID: MA
Workspace ID: MA20250202202209989000
Clicked Point (Latitude, Longitude): 42.59797, -71.98414
NHD Stream GNIS Name of Click Point: Stream name not found
Time: 2025-02-02 15:22:33 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0748	square miles
ELEV	Mean Basin Elevation	1160	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	7.44	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0748	square miles	0.16	512
ELEV	Mean Basin Elevation	1160	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	7.44	percent	0	32.3

Peak-Flow Statistics Disclaimers [Peak Statewide 2016 5156]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

Statistic	Value	Unit
50-percent AEP flood	7.12	ft^3/s
20-percent AEP flood	12.7	ft^3/s
10-percent AEP flood	17.6	ft^3/s
4-percent AEP flood	25.1	ft^3/s
2-percent AEP flood	31.5	ft^3/s
1-percent AEP flood	38.6	ft^3/s
0.5-percent AEP flood	46.5	ft^3/s
0.2-percent AEP flood	58.4	ft^3/s

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

NHD Features of Delineated Basin

NHD Streams Intersecting Basin Delineation Boundary

This functionality attempts to find the stream name at the delineation point. The name of the nearest intersecting National Hydrography Dataset (NHD) stream is selected by default to appear in the report above. NHD streams do not correspond to the StreamStats stream grid and may not be accurate. If you would like a different stream to appear in the above section, please make a selection below.

No NHD streams intersect the delineated basin.

Watershed Boundary Dataset (WBD) HUC 8 Intersecting Basin Delineation Boundary

This functionality attempts to find the intersecting HUC 8 of the delineated watershed. HUC boundaries do not correspond to the StreamStats data and may not be accurate.

HUC 8	Name
01080202	Millers River
01070004	Nashua River

NHD Hydrologic Features Citations

U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6. (https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6) U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4. (https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4)

Application Version: 4.26.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

HALEY & ALDRICH, INC.
600 S Meyer Avenue
Tucson, AZ 857011
520.289.8600

MEMORANDUM

23 February 2024
File No. 29913-027

TO:	Denis Bell, P.E. Haley & Aldrich, Inc.
FROM:	Christopher Langham, Abby Haneke Haley & Aldrich, Inc.
SUBJECT:	Emergency Action Plan Summary of Study – Extent of Inundation Old Duck Pond Dam NID MA 02784 Gardner, Massachusetts

Introduction

This memorandum summarizes the methods used by Haley & Aldrich, Inc. (Haley & Aldrich) to determine the extent of inundation in the event of a dam breach at the Old Duck Pond Dam (NID MA02784), in Gardner, Massachusetts.

Haley & Aldrich completed this inundation study to aid in the development of an Emergency Action Plan (EAP) for the Old Duck Pond Dam, as required by the Commonwealth of Massachusetts General Laws, M.G.L. 253, Section 44, Chapter 302 C.M.R. 10.00, "Dam Safety, dated February 10, 2017". The purpose of the EAP is to establish a basic plan of action if conditions at the dam indicate the potential for dam failure or if any individual observes and reports a dangerous condition developing at the dam.

Elevation Datum

Elevations referenced in this memorandum are provided in NAVD88.

Old Duck Pond Dam

In the Design Consultants Inc November 2018 "Old Duck Pond Dam Phase I Inspection/Evaluation" report, the Old Duck Pond Dam was classified as a SIGNIFICANT hazard structure. The following sections of this report summarize an inundation study for Old Duck Pond Dam, which will be used in the 2024 Old Duck Pond Dam EAP.

The Old Duck Pond Dam is an earthen embankment with the spillway blocked. The dam is approximately 400-feet long with a maximum height of approximately 12-feet. Embankment slopes are graded to between 1H to 2H:1V slope downstream with some locations vertical. The upstream embankment was flooded and couldn't be observed The maximum storage volume with the water level at the top of the Dam is approximately 61.4 acre-feet. The storage volume with the water level at the normal pool level is approximately 26.6 acre-feet.

Methods to Determine Inundation Extent

To determine the extent of inundation during a potential dike failure, Haley & Aldrich utilized the FEMA supported DSS-WISE Lite model for inundation mapping. The DSS-WISE Lite modeling program allows the user to input dam dimensions and breach parameters to run in a dam breach simulation. The model outputs a Simulation Report. The Simulation Report outlines all model inputs and assumptions, as well as the basic results of the simulation, including inundation maps overlaid on the DEM image.

Haley & Aldrich used the FEMA supported DSS-WISE Lite model to run two simulations: a "rainy-day breach" and a "sunny-day breach". The sunny-day breach model run is designed to simulate a dam breach due to a piping failure under otherwise normal conditions. The rainy-day breach model run is designed to simulate a dam failure due to overtopping under storm/high-water conditions.

HYDROGRAPH GENERATION

The DSS-WISE Lite modeling program allows the user to choose whether to input simulation parameters through a "Reservoir Type" simulation or a "Hydrograph Type" simulation. The "Reservoir Type" simulation requires the user to input specific parameters to model the impounded reservoir and breach geometry. In the "Hydrograph Type" simulation, the user provides a breach hydrograph, which the model propagates downstream. For this study, Haley & Aldrich utilized the "Hydrograph Type" simulation in DSS-WISE Lite.

Breach Hydrograph

To generate a breach hydrograph for the Old Duck Pond Dam, Haley & Aldrich used the "Dam Breach Hydrograph TR-60 version 3" excel spreadsheet provided on the Natural Resources Conservation Services (NRCS) website.

This spreadsheet allows the user to calculate a breach hydrograph by inputting dam dimensions. The spreadsheet references the NRCS National Engineering Manual (NEM) section 520.2 and uses the TR-60 equations from that reference to calculate a breach hydrograph.

Haley & Aldrich input the following values into this spreadsheet to calculate a breach hydrograph for the Old Duck Pond Dam. This hydrograph generation assumes a full pool with no antecedent flow.

Dam Crest Height = 12 ft

Water Surface Elevation at Time of Breach = 1145.76ft
Dam Top Width = 15-20 ft
Dam Side Slope (upstream) = Unknown
Dam Side Slope (downstream) = 1-2
Valley Floor Elevation = Unknown
Reservoir Volume at Time of Breach = 61.4 acre-feet
Valley Width at Dam Axis and Water Surface Elevation = Unknown
Timestep for Breach Hydrograph = 5 Minutes

These calculations and resulting breach hydrograph can be found in Attachment A of this memorandum.

Unit Hydrograph

To generate a unit hydrograph (to model storm/high-water conditions for the rainy-day simulation), Haley & Aldrich used the "Unit Hydrograph Transformer" excel spreadsheet provided on the NRCS website.

The spreadsheet allows the user to calculate a dimensionless SCS unit hydrograph that can be used to represent a discharge versus time hydrograph for any given watershed. This calculation uses a formula provided in the NRCS document "NEH 630 Hydrology", chapter 16, equation 16A-13. The user inputs time of concentration, drainage area, and peak rate factor to the spreadsheet, and it calculates the unit hydrograph and S-curves for the given information.

For the Old Duck Pond Dam, Haley & Aldrich input the following values into this spreadsheet:

Time of Concentration = 1.4 Hours
Drainage Area = 0.07 mi^2
Peak Rate Factor = 484 (dimensionless)

These calculations and resulting unit hydrograph can be found in Attachment B of this memorandum.

DSS-WISE LITE SIMULATIONS

Sunny-Day Breach

To model a sunny-day breach scenario, Haley & Aldrich input the NRCS spreadsheet-generated breach hydrograph into DSS-WISE Lite. The breach hydrograph used assumes a breach scenario with a full pool and no antecedent flow at the time of the breach. This breach hydrograph showed a peak flow rate during the breach of about 1,596 cubic feet per second (cfs). The input hydrograph can be found in Attachment C of this memorandum.

In addition to the breach hydrograph, Haley & Aldrich also input the following parameters into the DSS-WISE Lite Prep Tool:

Impounding Structure Characteristics

Structure Type:	Embankment
Crest Elevation (ft):	1144.26
Length (ft):	371

Failure Conditions

Failure Mode:	Sudden and Complete Breach
Breach Location: (Latitude/Longitude)	42.5978205568/ -71.984286

The DSS-WISE Lite simulation for a sunny-day breach estimated that the potential flood (2 ft or greater in depth) would travel about 0.9 miles downstream of the Old Duck Pond Dam, and generated inundation maps based on these inputs.

The sunny-day Simulation Report (including inundation maps) can be found in Attachment D of this memorandum.

Rainy-Day Breach

To model a rainy-day breach scenario, Haley & Aldrich used both the unit hydrograph and the breach hydrograph in tandem to simulate the overtopping of the dam. The peak flows of each hydrograph were added together to create a rainy-day peak flow rate during the breach of approximately 9,217 cfs. This input hydrograph can be found in Attachment C of this memorandum.

In addition to the rainy-day breach hydrograph, Haley & Aldrich also input the following parameters into the DSS-WISE Lite Prep Tool:

Impounding Structure Characteristics

Structure Type:	Embankment
Crest Elevation (ft):	1144.26
Length (ft):	371

Failure Conditions

Failure Mode:	Sudden and Complete Breach
Breach Location: (Latitude/Longitude)	42.5977287693/ -71.9841222979

The DSS-WISE Lite simulation for a rainy-day breach estimated that the potential flood (2 ft or greater in depth) would travel about 0.9 miles downstream of the Dow Brook Reservoir Dam, and generated inundation maps based on these inputs.

The rainy-day Simulation Report (including inundation maps) can be found in Attachment E of this memorandum.

Enclosed Attachments:

- Attachment A – NRCS Breach Hydrograph Calculation
- Attachment B – NRCS Unit Hydrograph Calculation
- Attachment C – DSS-WISE Lite Input Hydrographs
- Attachment D – Sunny-Day Simulation Report
- Attachment E – Rainy-Day Simulation Report

References

FEMA supported DSS-WISE Lite web application.

Haley & Aldrich, Inc. “Dow Brook Reservoir Dam Phase 1 Inspection/Evaluation” dated August 29, 2017.

Natural Resources Conservation Service (NRCS) Dam Breach Hydrograph webpage and “DamBreachHydrographTR60ver3” excel spreadsheet dated July 3, 2018.

Natural Resources Conservation Service (NRCS) Unit Hydrograph webpage and “UHtransformerVer3” excel spreadsheet dated August 2016.

G:\29913\027-OldDuckPond\EAP\Technical Memo\2024-0223-HAI_SummaryofInundationStudy-TechnicalMemo_D1.docx

Attachment A

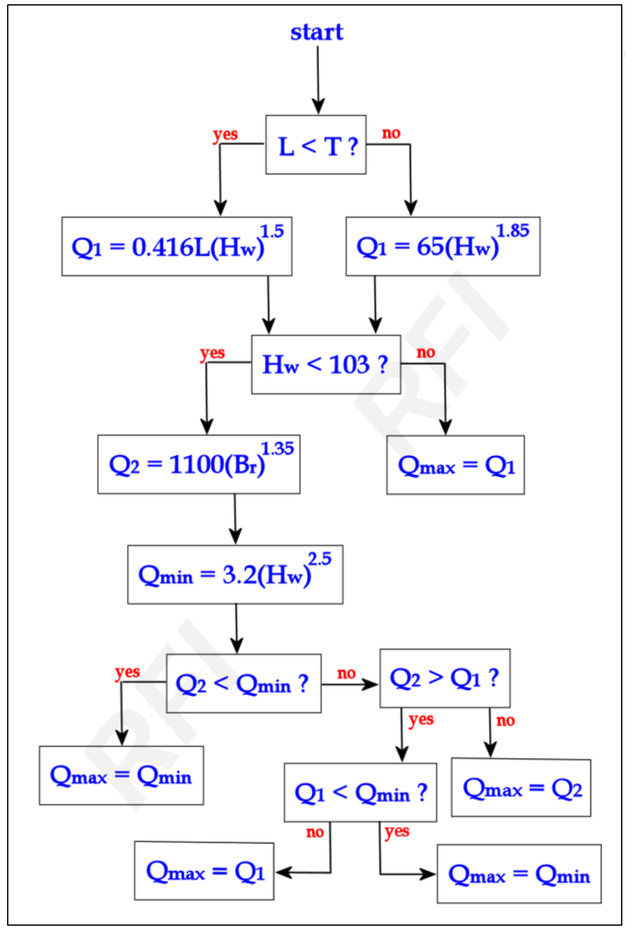
NRCS Breach Hydrograph Calculation

Welcome to DamBreachHydrographTR60.

This tool takes dam embankment and reservoir storage information as input and computes a dam breach peak outflow, using TR-60 equations, and an associated dam breach hydrograph, using the TR-66 AttKin curvilinear routing equations.

This button opens a web page: go get TR-60 and / or TR-66

The flow chart at right shows the TR-60 guidance, which depends on key factors, such as whether the reservoir head at breach time is more or less than 103 feet, and the volume of water stored behind the dam.



The user must insert input on the data sheet in the gray-shaded cells. The output is automatically computed in the output section, light blue cells.

In addition, the breach outflow hydrograph is automatically generated, given the user-desired hydrograph timestep. (This timestep may be chosen based on intended use in other programs, such as HecRAS.)

A button on the data sheet gives the user the option to have the program automatically adjust the graph scale.

NOTE:

The user must decide on a reasonable "floor elevation" from which H_w is determined.
For dams on steep streams the choice of floor elevation may significantly effect results.
The user may wish to select a floor elevation as high as the "alt floor" as shown in the sketch on the data sheet.
For steep streams the selection of floor elevation may be guided by the engineering judgement of the reasonable maximum depth a breach may penetrate into the embankment.

See the NRCS National Engineering Manual (NEM), section 520.2 on Dams for more information. go get NEM 520.2 on Dams

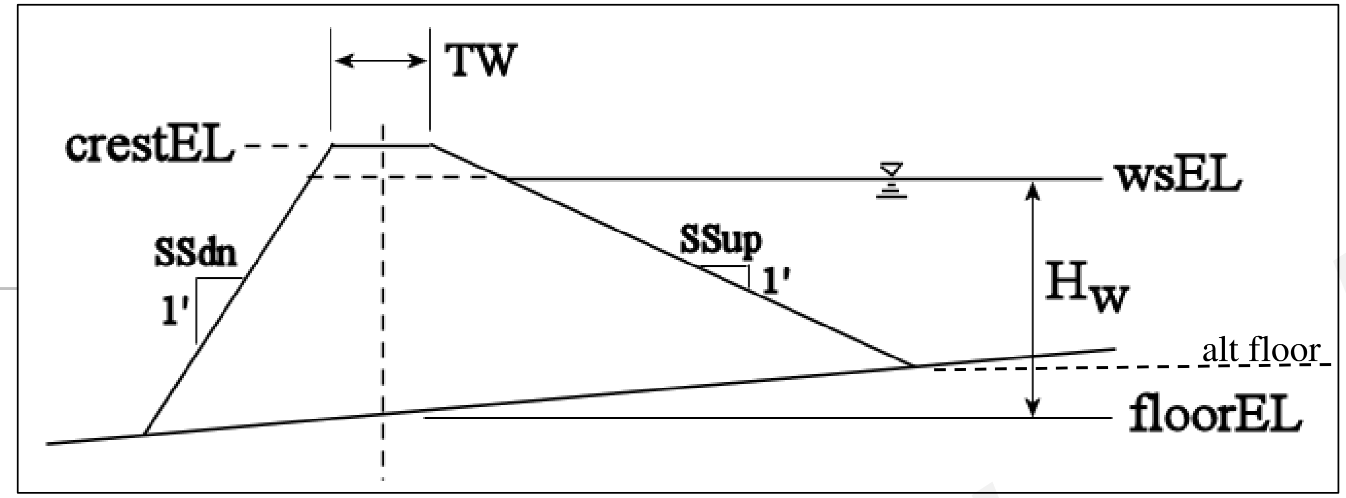
Dambreach Hydrographs via TRs 60 & 66 NRCS guidance

version 3, July 2018

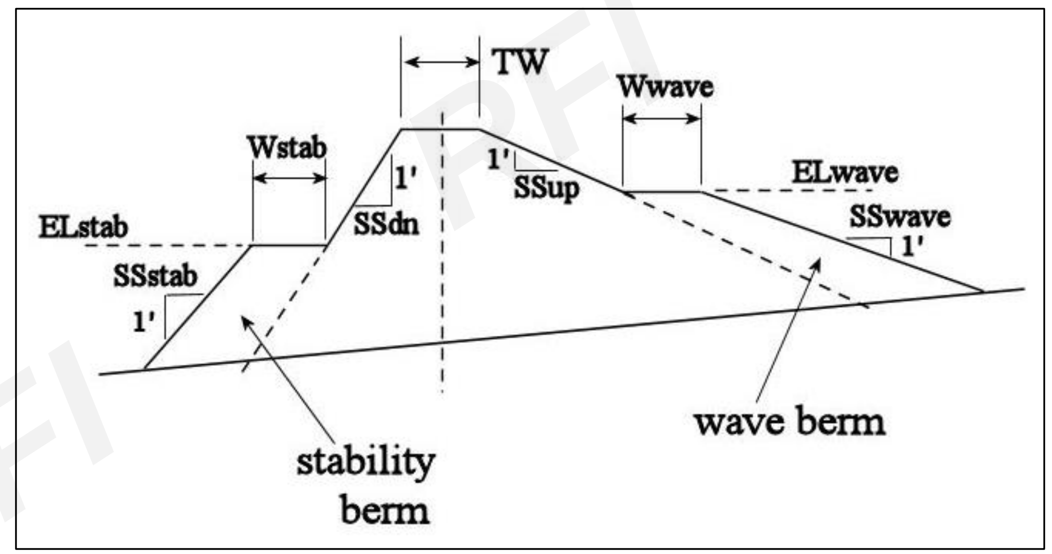
Input data required:

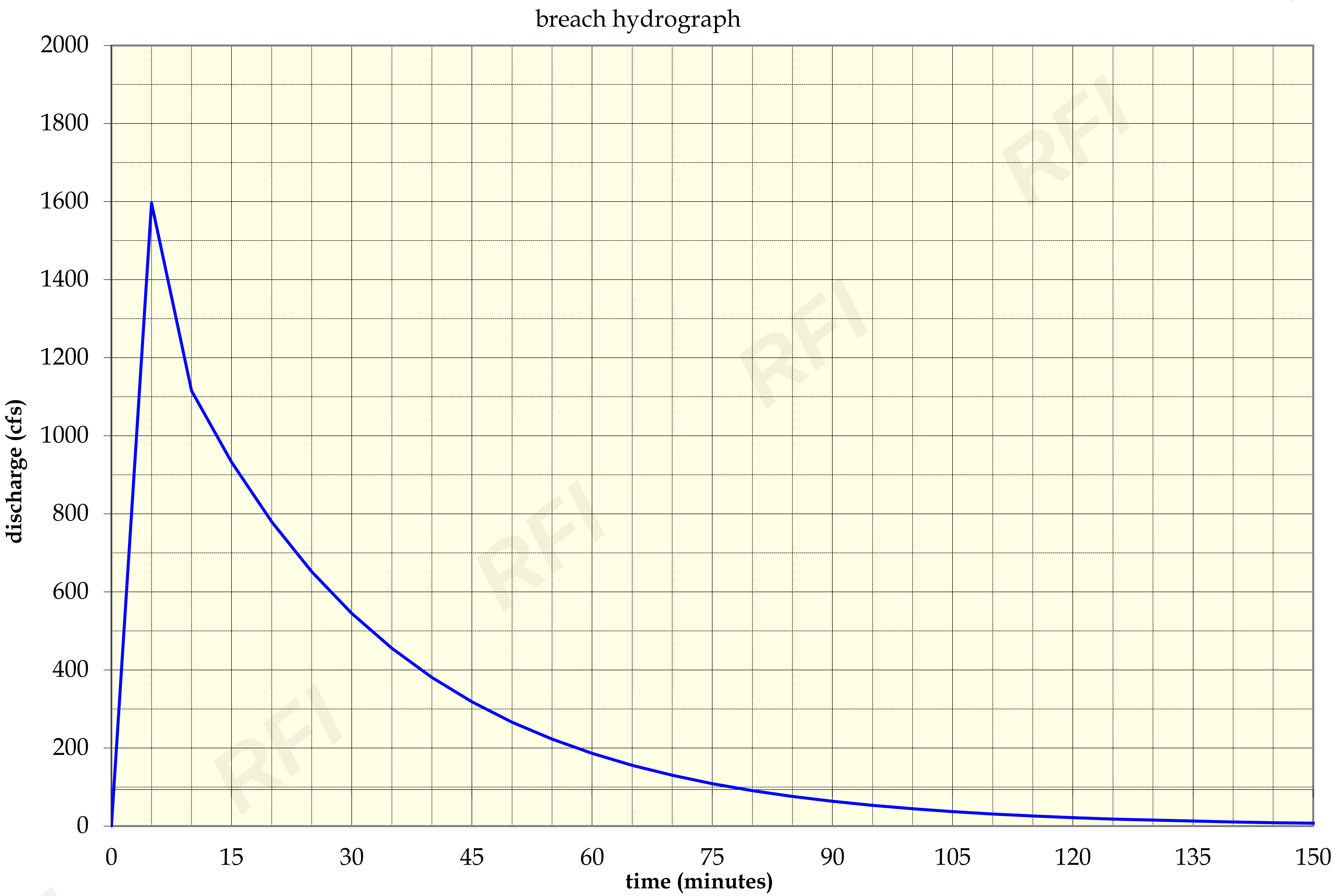
data	variable	explanation
1145.76	crestEL	dam crest elevation
1145.76	wsEL	w.s. elev at time of breach
30	TW	dam top width (feet)
1	SSup	dam side slope (upstream, SSup:1)
2	SSdn	dam side slope (downstream, SSdn:1)
1133.76	floorEL	valley floor elev (see note)
61.4	Vs	resv vol at time of breach (acre-feet)
400	L	valley width at dam axis & w.s. elev (feet)
	ELwave	top of wave berm elevation
	Wwave	width of top of wave berm feet
	SSwave	wave berm side slope (SSwave:1)
	ELstab	top of stability berm elevation
	Wstab	width of top of stability berm (feet)
	SSstab	stability berm side slope (SSstab:1)
5	ts	timestep (minutes) for breach hydrograph

output		breach hydrograph	
variable	**results**	**time (min)**	**Q (cfs)**
T	373	0	0
(L < T)?	N	5	**1596**
H_w	12	10	1116
Q_1	6448	15	933
(H_w < 103)?	Y	20	780
Awave	0	25	652
Astab	0	30	545
A	576	35	456
Br	1	40	381
Q_2	1534	45	319
Q_{min}	1596	50	266
($Q_2 < Q_{min}$)?	Y	55	223
($Q_2 > Q_1$)?	N	60	186
($Q_1 < Q_{min}$)?	N	65	156
Q_{max}	**1596**	70	130
		75	109
		80	91
		85	76



auto-scale hydrograph





breach hydrograph
2000
1800
1600
1400
1200
1000
800
600
400
200
0
discharge (cfs)
0
15
30
45
60
75
90
105
120
135
150
time (minutes)

Attachment B

NRCS Unit Hydrograph Calculation

Unit Hydrograph Transformer

see comment — version 3, Aug 2016 — contact: dan.moore@por.usda.gov

input needed:

T_c = 1.4 time of concentration (hrs)

A = 0.07 drainage area (mi^2)

P_K = 484 peak rate factor (PRF, dimensionless)

calculate UH & S-curve

1.00

maxX=

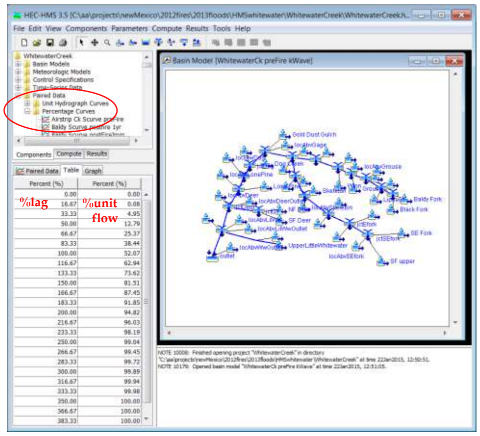
maxY= 3200

unit hydrograph: — **S-curve:** **lag = 0.840** (hrs)

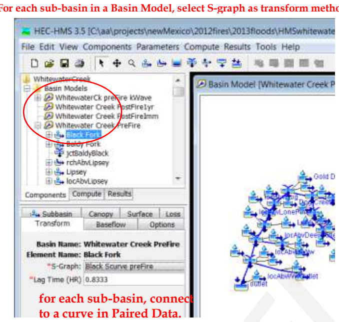
time (min)	discharge (CFS)	%lag	%unit flow
0	0	0.0	0.0
5	1.0	9.9	0.54
10	3.3	19.8	1.71
15	6.2	29.8	3.24
20	10.0	39.7	5.74
25	14.8	49.6	9.43
30	20.7	59.5	14.05
35	27.0	69.4	19.81
40	32.2	79.4	26.23
45	35.9	89.3	32.78
50	37.9	99.2	39.62
55	38.4	109.1	46.29
60	38.2	119.0	52.73
65	36.7	129.0	58.78
70	34.4	138.9	64.27
75	31.9	148.8	69.38
80	28.9	158.7	73.87
85	25.3	168.7	77.49
90	21.3	178.6	80.48
95	17.8	188.5	83.17
100	15.4	198.4	85.53
105	13.3	208.3	87.41
110	11.5	218.3	89.15
115	10.0	228.2	90.76
120	8.8	238.1	91.98
125	7.6	248.0	93.12
130	6.6	257.9	94.19
135	5.6	267.9	94.89
140	4.9	277.8	95.67
145	4.2	287.7	96.38
150	3.7	297.6	96.80
155	3.2	307.5	97.31
160	2.7	317.5	97.80
165	2.4	327.4	98.03
170	2.0	337.3	98.36
175	1.8	347.2	98.73
180	1.5	357.1	98.82
185	1.3	367.1	99.06
190	1.1	377.0	99.32
195	1.0	386.9	99.34
200	0.9	396.8	99.50
205	0.8	406.7	99.71
210	0.7	416.7	99.75
215	0.5	426.6	99.79
220	0.5	436.5	100.00
225	0.4		
230	0.4		
235	0.3		
240	0.3		
245	0.2		
250	0.2		
255	0.2		
260	0.1		
265	0.1		
270	0.1		
275	0.0		
280			
285			
290			
295			
300			
305			
310			
315			
320			
325			
330			
335			
340			
345			
350			
355			
360			
365			
370			
375			
380			
385			
390			
395			
400			
405			
410			
415			
420			
425			
430			
435			
440			
445			
450			
455			

To use in HecHMS:

Store all the S curves in Paired Data (one for each sub-basin):



For each sub-basin in a Basin Model, select S-graph as transform method, then connect to paired data:



for each sub-basin, connect to a curve in Paired Data. Get Lag Time in Cell E11

equations used:

$$\Delta D = 0.133 T_c$$ NEH 630 16A-13

$$L = 0.6 T_c$$ NEH 630 15-3

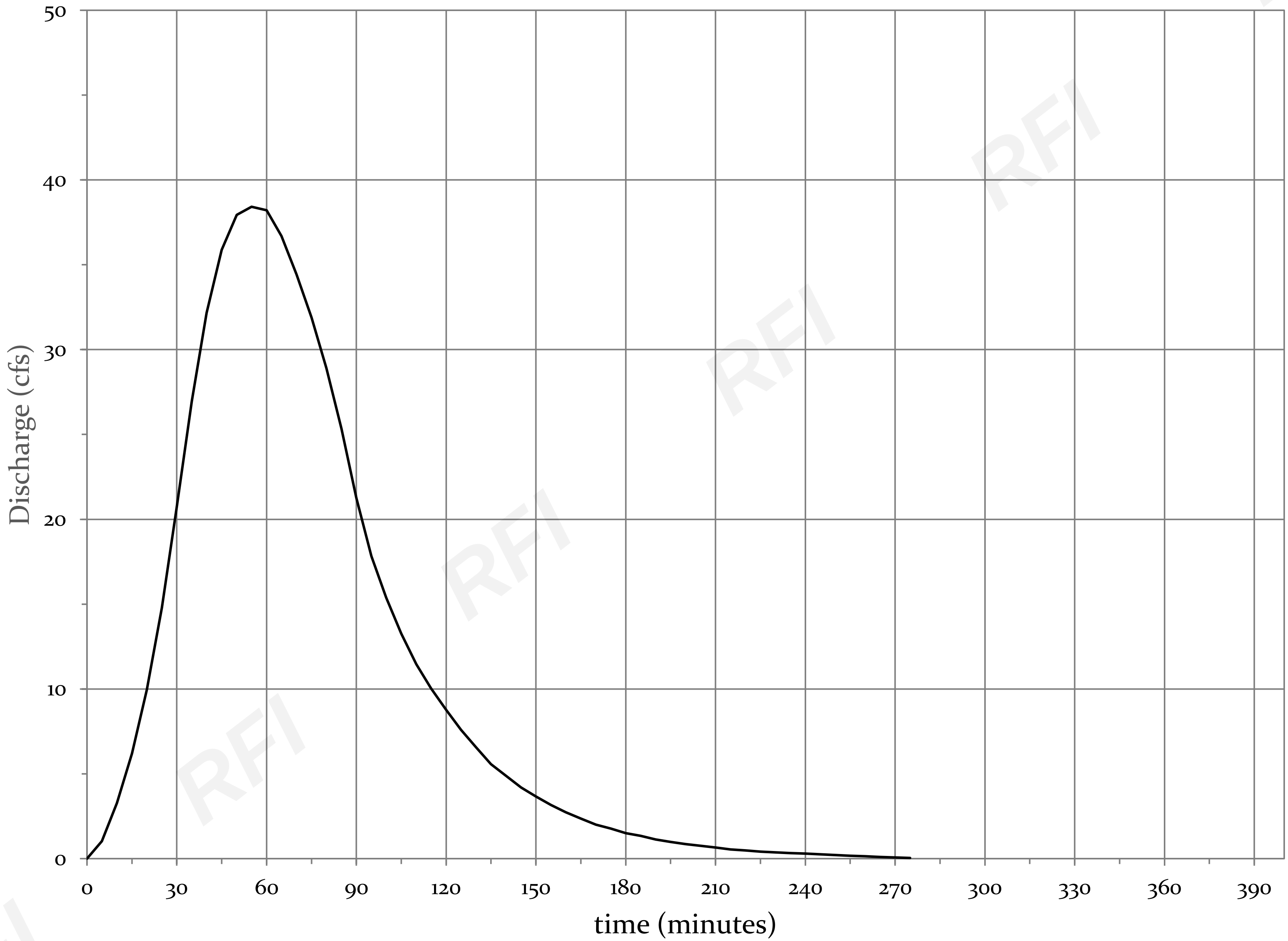
$$T_p = \frac{\Delta D}{2} + L$$ NEH 630 16A-7

$$q_p = \frac{P_k A Q}{T_p}$$ NEH 630 16A-6, Q is one inch

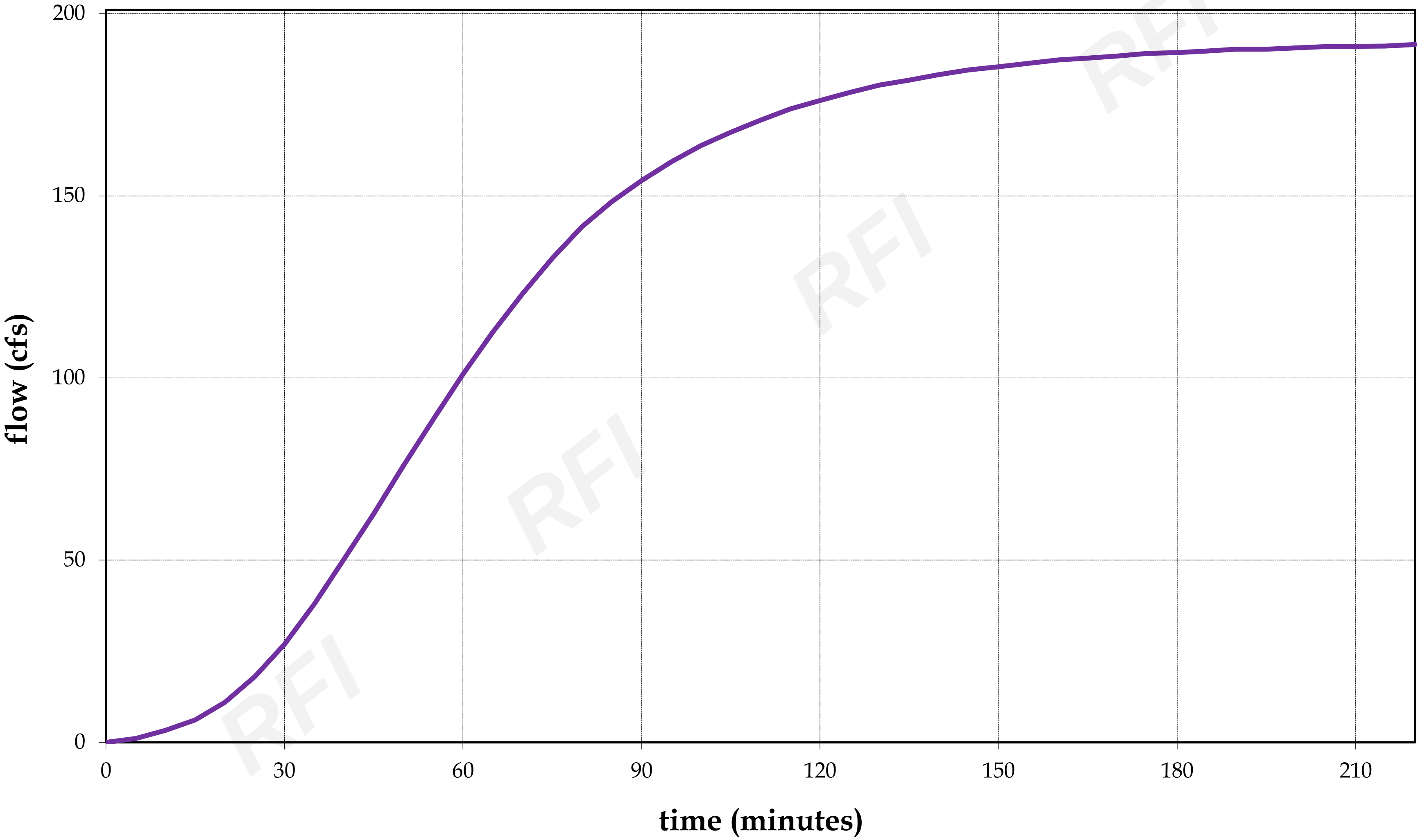
gamma equation:

$$\frac{q}{q_p} = e^m * \left(\frac{t}{t_p}\right)^m * e^{\left(-m\frac{t}{t_p}\right)}$$ NEH 630 16-1

$$PRF = \frac{645.33}{timestep * \sum \frac{q}{q_p}}$$ NEH 630 16A-2



Discharge (cfs)
0
10
20
30
40
50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
time (minutes)

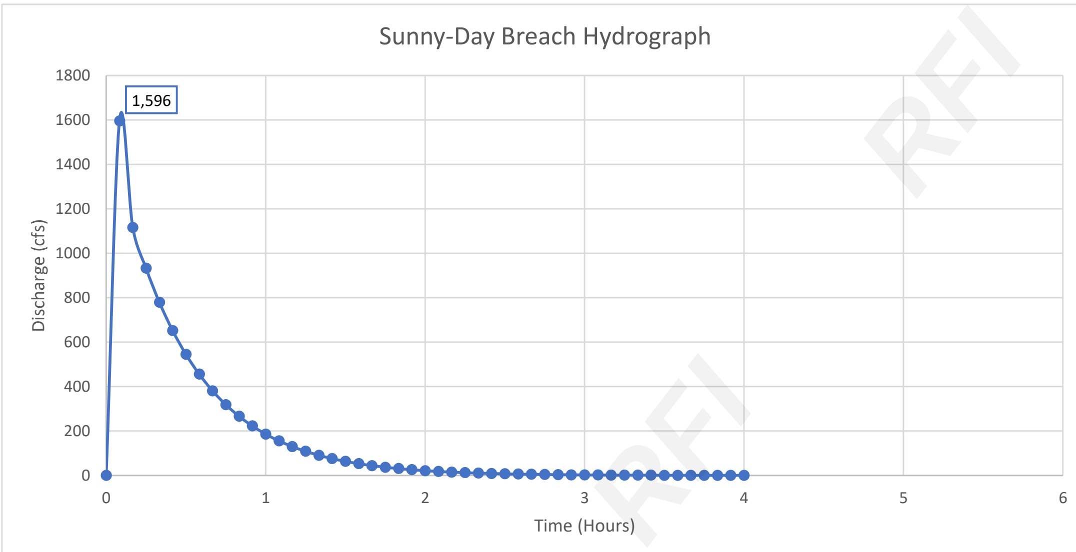


200
150
100
50
0
flow (cfs)
0
30
60
90
120
150
180
210
time (minutes)

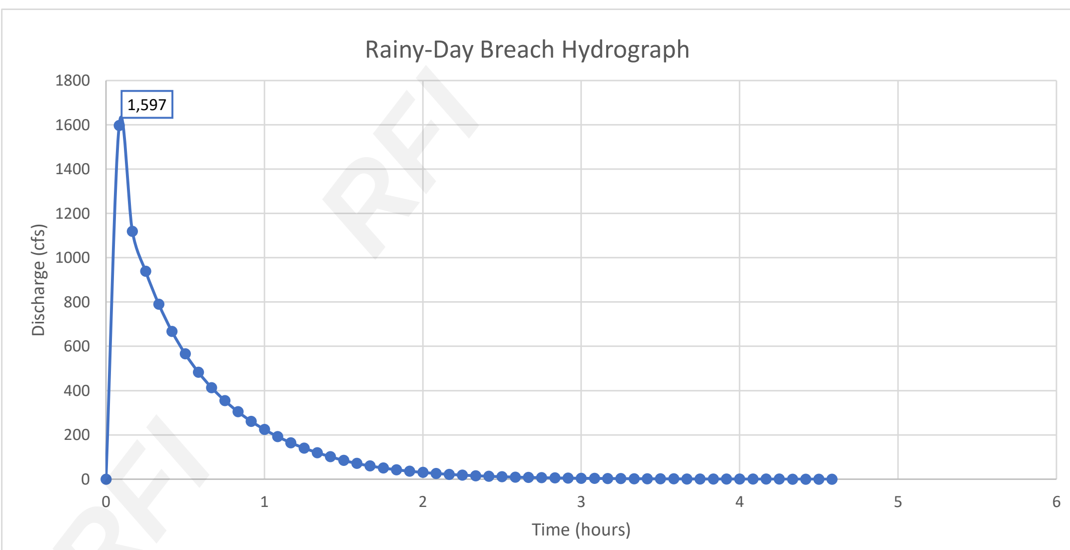
Attachment C

DSS-WISE Lite Input Hydrographs

HALEY ALDRICH



Note: This hydrograph is just the breach hydrograph calculated by the NRCS spreadsheet.



Note: This hydrograph is the addition of the NRCS calculated unit hydrograph and breach hydrograph.

Attachment D

Sunny-Day Simulation Report

HALEY ALDRICH

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ Lite Flood Simulation Report

Hydrograph-type, sudden and complete br
each

Sunny Day Breach - Old Duck Pond

NAXXXXX

February 22, 2024

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

FOR OFFICIAL USE ONLY

Table of Contents

1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
`https://dsswiseweb.ncche.olemiss.edu`

Disclaimer

The National Center for Computational Hydroscience and Engineering (NCCHE), The University of Mississippi, makes no representations pertaining to the suitability of the results provided herein for any purpose whatsoever. All content contained herein is provided "as is" and is not presented with any warranty of any form. NCCHE hereby disclaims all conditions and warranties in regard to the content, including but not limited to any and all conditions of merchantability and implied warranties, suitability for a particular purpose or purposes, non-infringement and title. In no event shall NCCHE be liable for any indirect, special, consequential or exemplary damages or any damages whatsoever, including but not limited to the loss of data, use or profits, without regard to the form of any action, including but not limited to negligence or other tortious actions that arise out of or in connection with the copying, display or use of the content provided herein.

Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Sunny Day Breach - Old Duck Pond
Scenario Name:	Hydrograph-type, sudden and complete br each
NIDID:	NAXXXXX
Scenario Description:	1 active reservoir 1 active impounding structure hydrograph-type, sudden and c omplete breach of Dam 1
User e-mail:	ahaneke@haleyaldrich.com
Group:	MASSACHUSETTS

2.2 Simulation Parameters

Domain buffer distance (miles):	10
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	5

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Dam 1
Structure Type:	Embankment
Hydraulic Height (ft):	12.0
Crest Elevation (ft):	1144.26
Length (ft):	370.813156292

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 User-Drawn Levees

Number of User-Drawn Levees: 0

2.6 User-Specified Breach Hydrograph

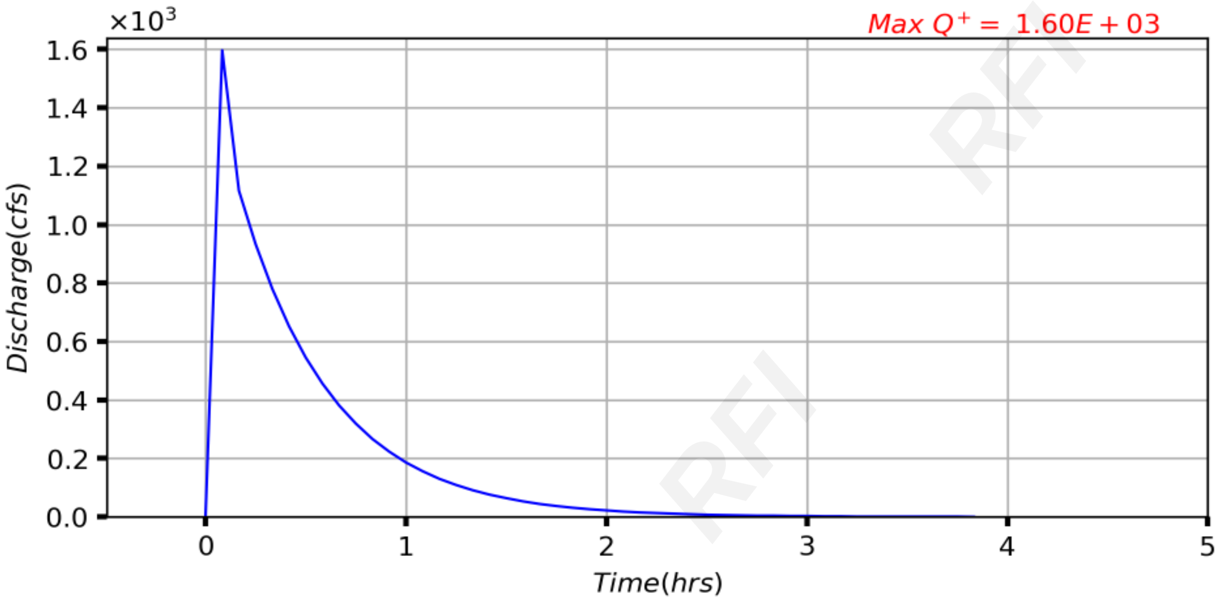


Figure 1. Breach inflow hydrograph for: Dam 1.

2.7 Reservoir Characteristics

Number of Reservoirs: 1

Reservoir Name:	Reservoir 1
Selected Reservoir Point (Latitude/Longitude):	42.5977287693/-71.9841222979
Pool Elevation @ Max Storage (ft):	1145.76
Maximum Storage Volume (ac-ft):	61.4
Pool Elevation @ Normal Storage (ft):	1144.26
Normal Storage Volume (ac-ft):	26.6
Pool Elevation @ Failure (ft):	1145.76
Failure Storage Volume (ac-ft):	61.4

2.8 Failure Conditions

Structure Name:	Dam 1
Structure Type:	Embankment
Failure Mode:	Total Dam Breach
Breach Location (Latitude/Longitude):	42.5978205568/-71.984286

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.
2. Burn U.S. Army Corps of Engineers (USACE) levee lines and group-specific levee lines (if any) within the AOI, as well as any user-drawn levees into the DEM.
3. Assign Manning's coefficients based on LULC classifications.
4. Validate user provided simulation input parameters.
5. Remove user identified bridges from the DEM.
6. Estimate reservoir bathymetry.
7. Extend impounding structures if the specified reservoir level cannot be contained.
8. Fill reservoir to specified failure elevation.
9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

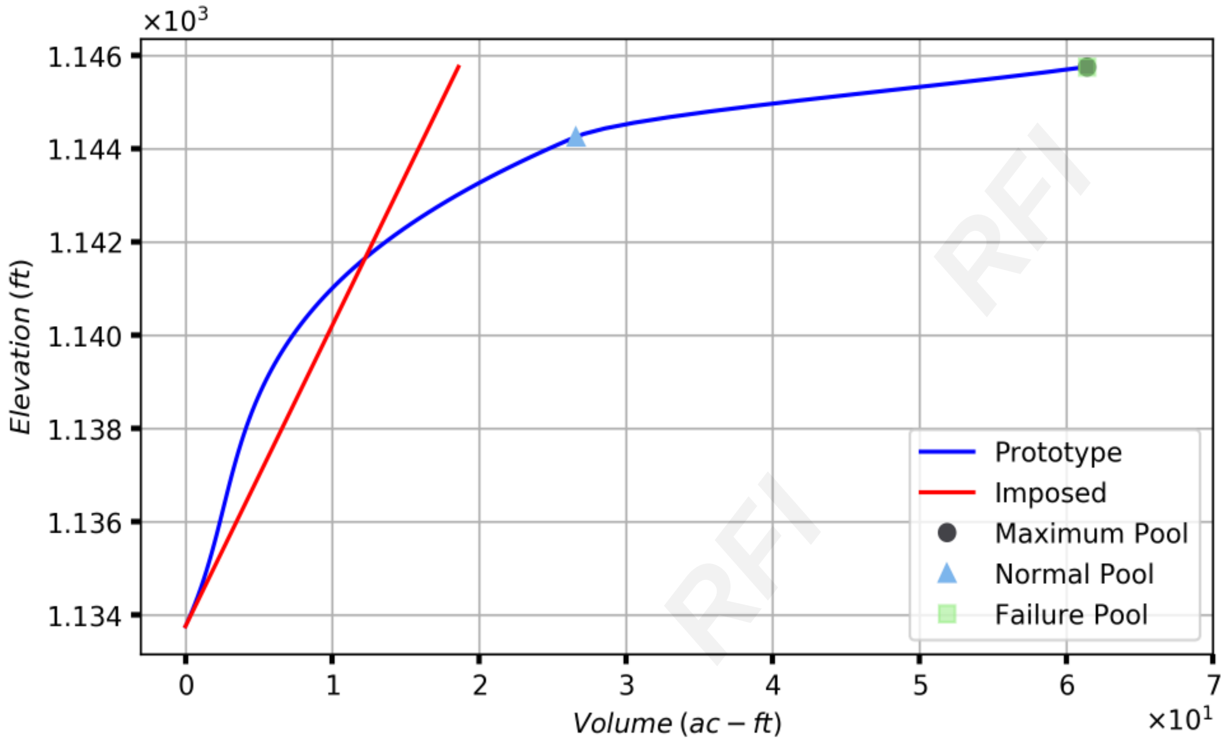


Figure 2. Stage-Volume Curve for Reservoir: Reservoir 1.

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.
Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.
User-given Storage Volume at Failure (ac-ft): 61.4
Imposed Storage Volume at Failure (ac-ft): 18.6
After filling to the failure elevation, the imposed reservoir volume matched 30.3% of the prototype volume.

Extended Structures:
Dam 1 has been extended to contain the reservoir.

3.3 Data Sources

1. Digital Elevation Models

   Sources: USGS 3D Elevation Program (3DEP) 2019 datasets, NOAA, and any group-specific DEM data if provided

   Resolutions: 2, 1, 1/3, and 1/9th arc-second, 1 meter, and varying resolutions of group-specific DEM data (if any), based upon availability

   Vertical Datum: NAVD88

   Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

   Sources: USGS 2016 (CONUS), 2011 (Alaska), and 2001 (Hawaii and Puerto Rico)

   Resolution: 30 m

3. National Levee Database

   Source: USACE

4. Group-specific levee data

   Source: Provided by individual groups

3.4 Digital Elevation Model

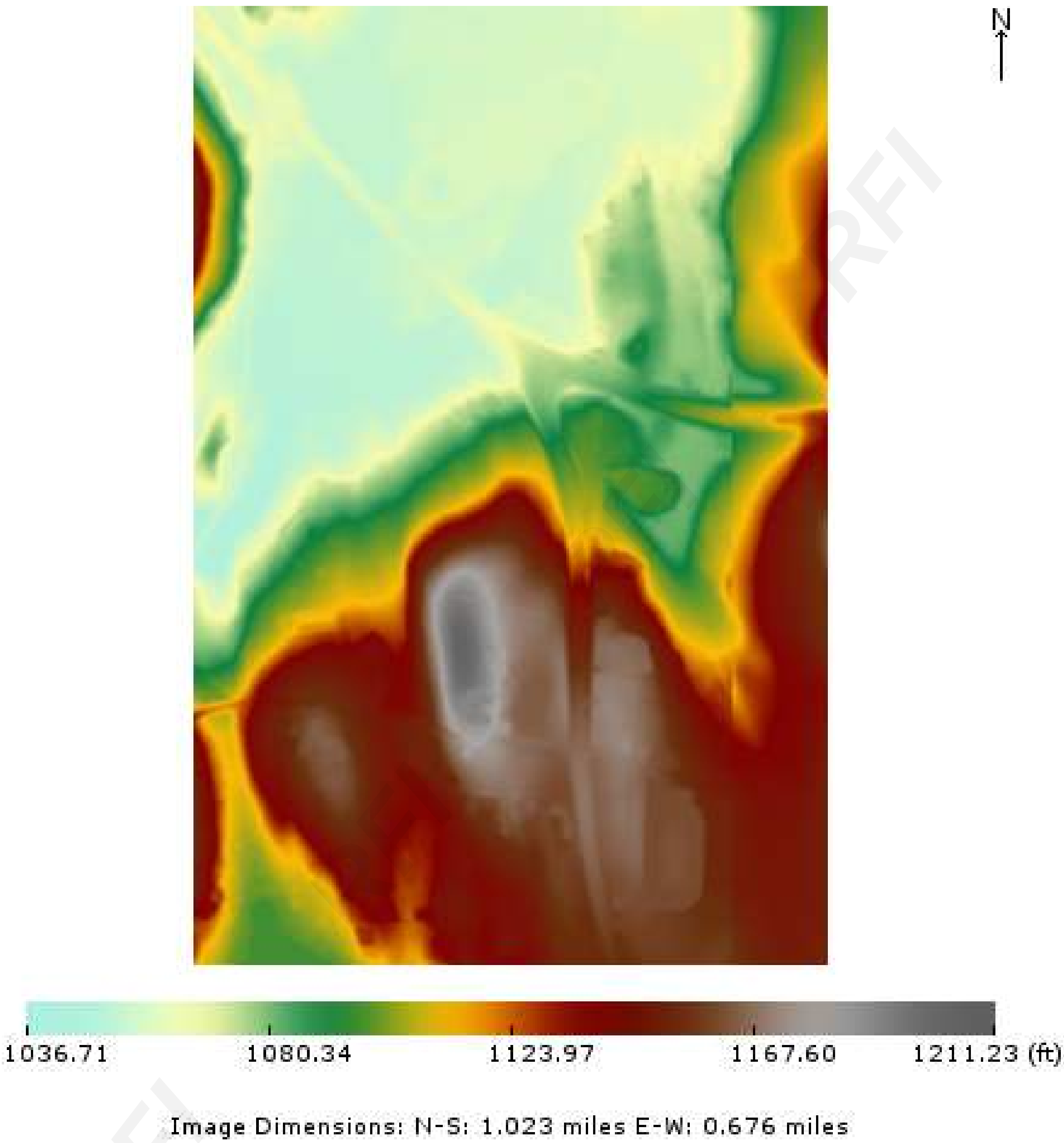


Figure 3. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

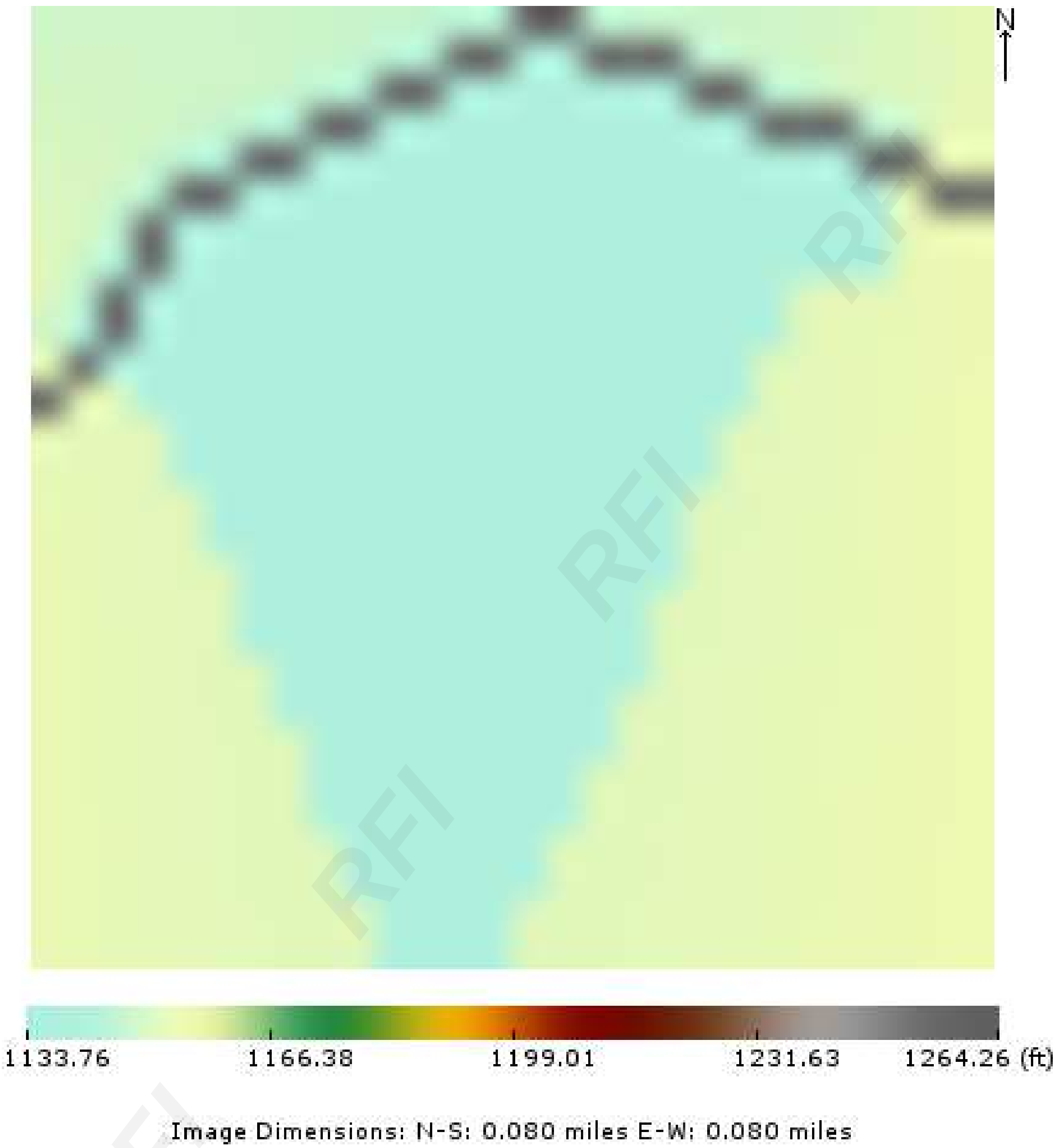


Figure 4. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

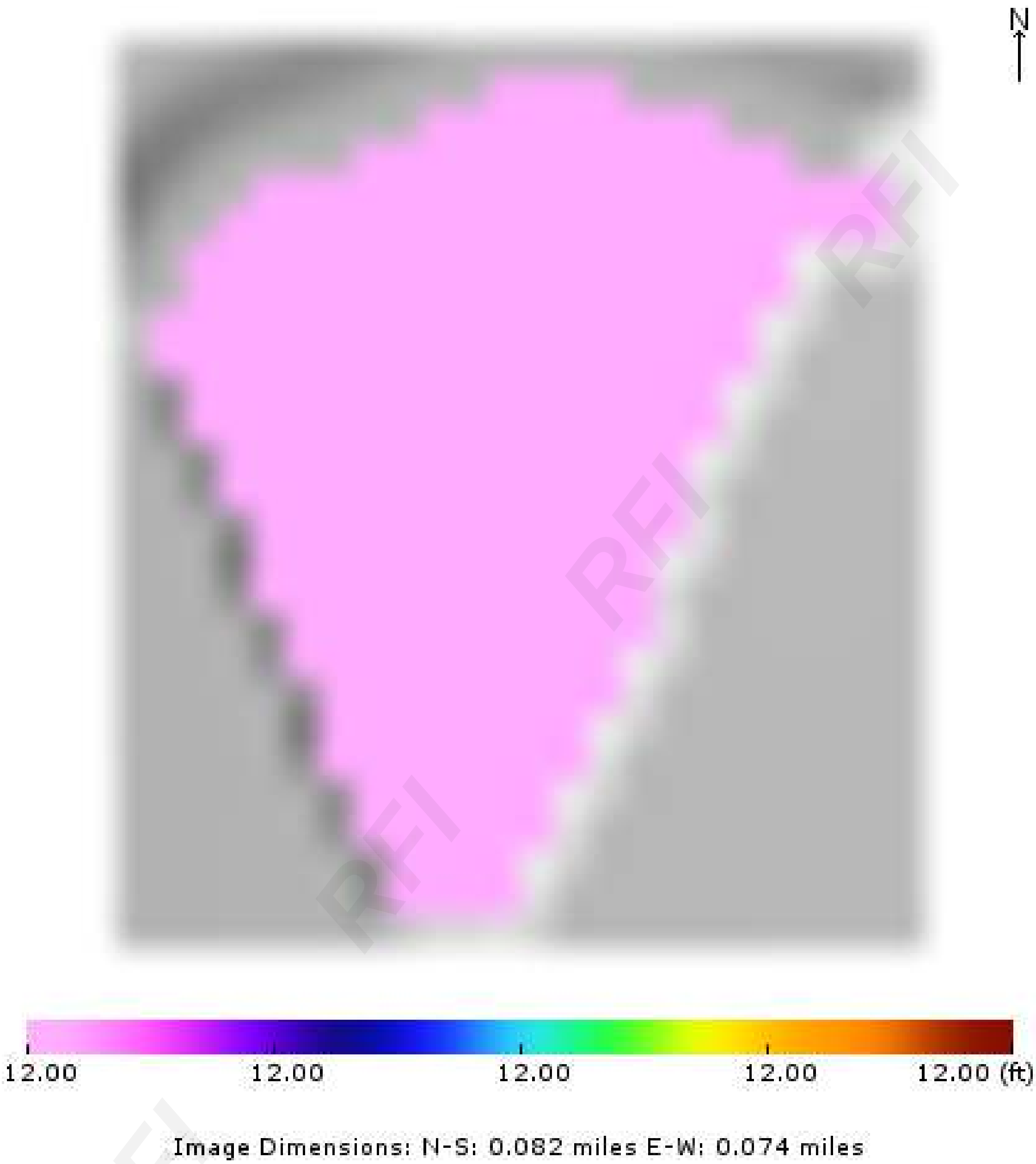


Figure 5. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover

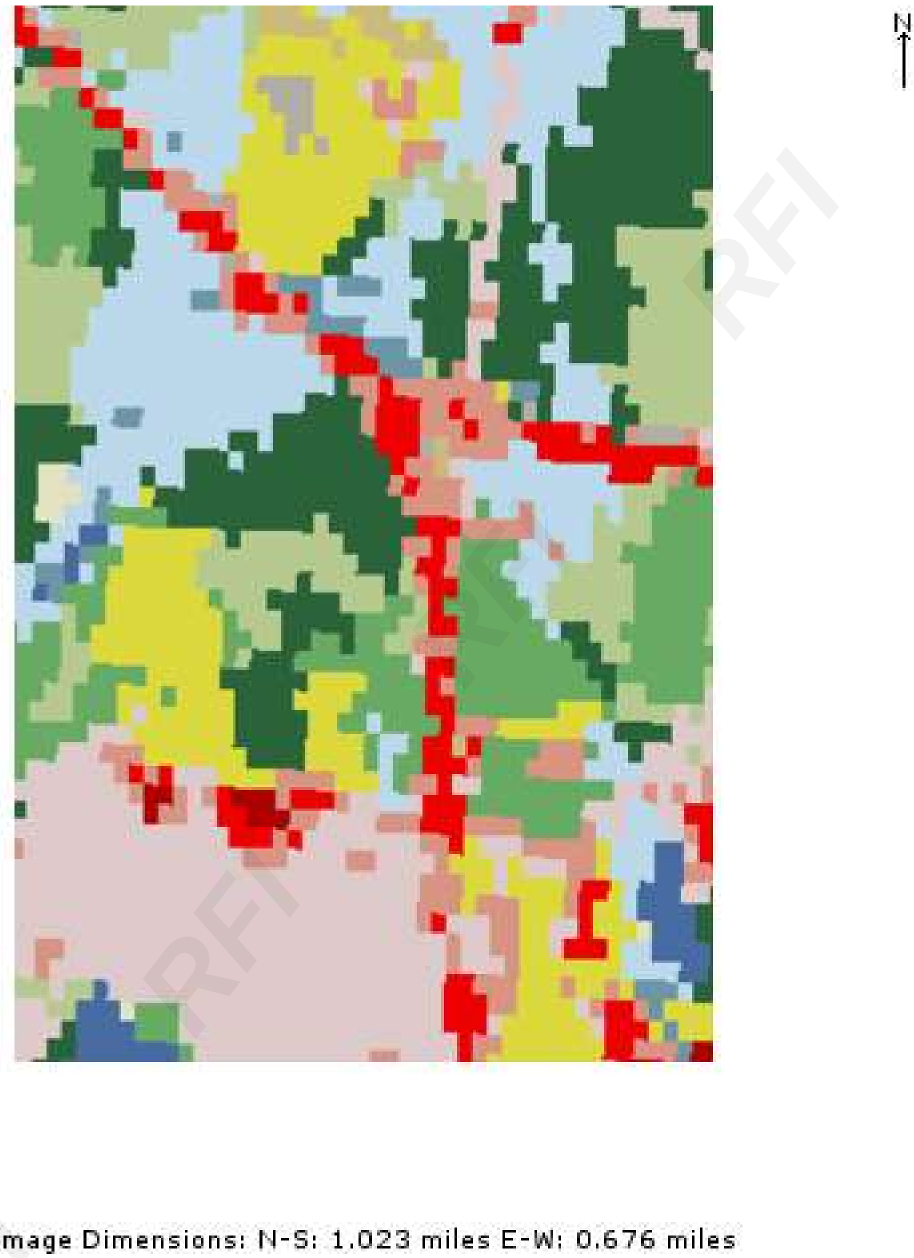


Figure 6. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	10:43 AM CST (02/22/2024)
Simulation Start Time:	10:44 AM CST (02/22/2024)
Simulation End Time:	10:45 AM CST (02/22/2024)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	0.9
Domain buffer distance (miles):	10
Elapsed simulation time after breach initiation (hrs):	11.3
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Woody Wetlands	45.16	0.1500	90	
Developed, Low Density	9.47	0.0678	22	
Hay/Pasture	8.99	0.0350	81	
Evergreen Forest *	7.56	0.1000	42	
Emergent Herbaceous Wetlands	7.35	0.1825	95	
Developed, Open Space	5.69	0.0404	21	
Open Water	5.04	0.0330	11	
Developed, Medium Density	4.67	0.0678	23	
Mixed Forest *	3.21	0.1200	43	
Deciduous Forest *	2.27	0.1000	41	
Barren Land	0.28	0.0113	31	
Grassland/Herbaceous	0.24	0.0400	71	
Unclassified	0.00	0.0350	0	
Perennial Snow/Ice	0.00	0.0100	12	
Developed, High Density	0.00	0.0404	24	
Dwarf Scrub *	0.00	0.0350	51	
Shrub/Scrub	0.00	0.0400	52	
Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	
Cultivated Crops	0.00	0.0700	82	

Note: * indicates an n-value estimated by NCCHE. ** indicates an n-value given by the user. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets

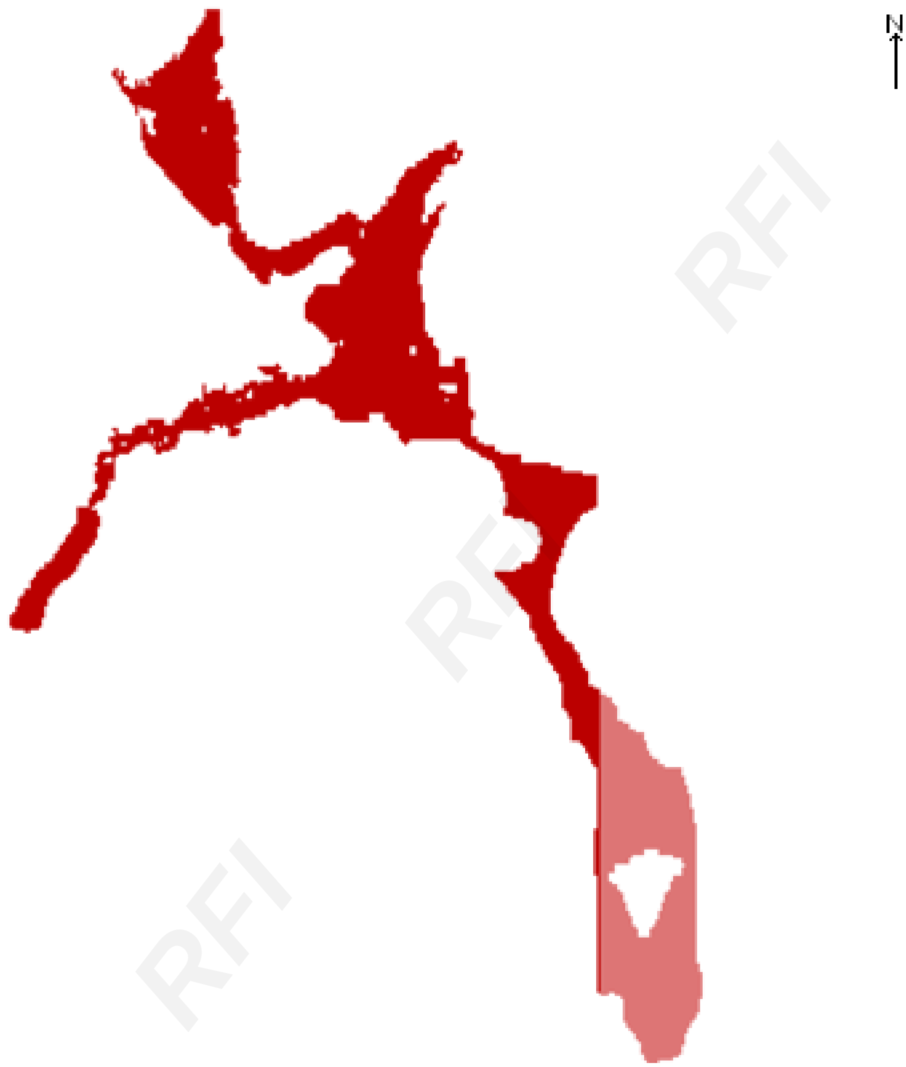


Figure 7. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	
USGS	1 meter	usgs_utm_z19_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

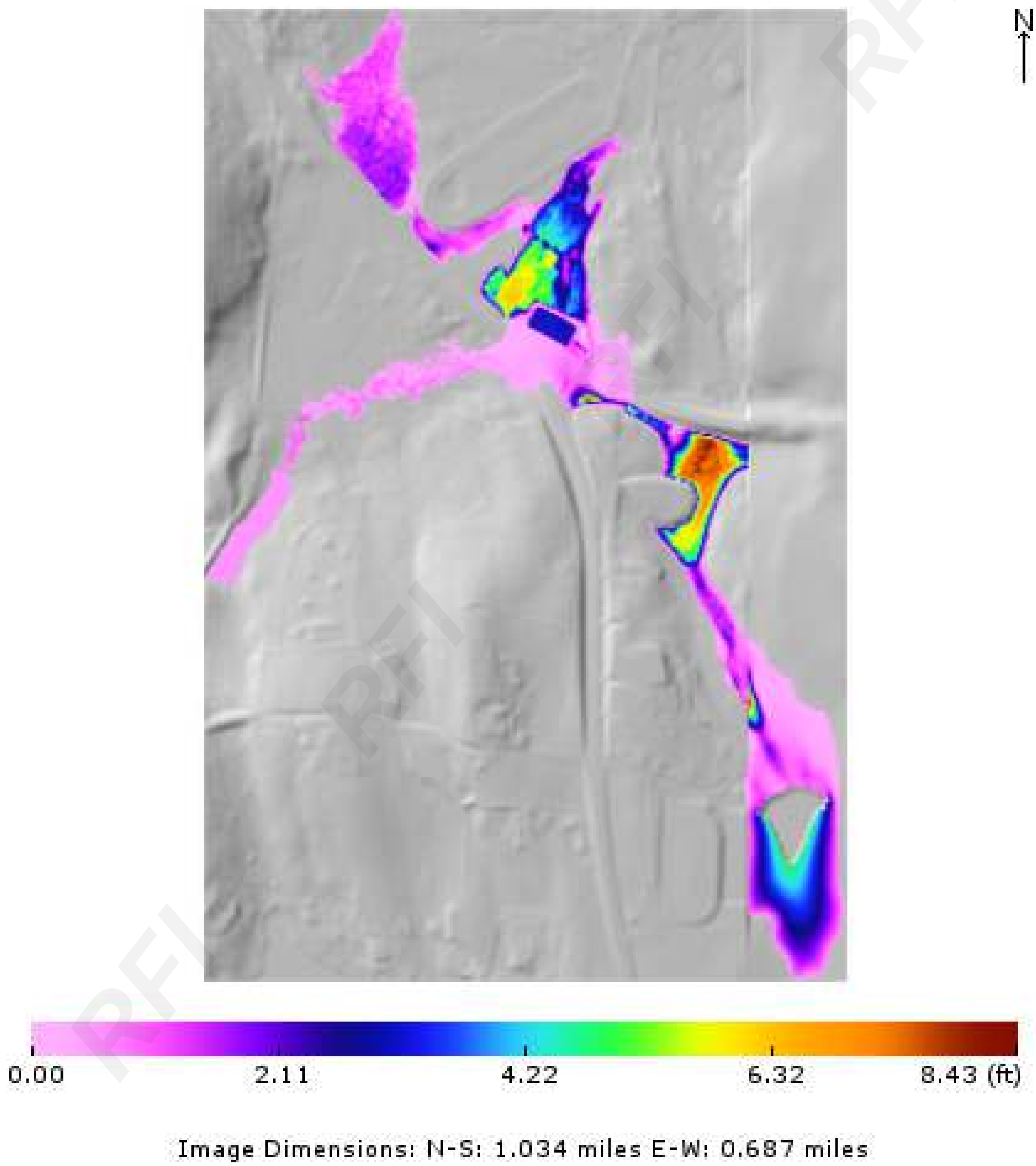


Figure 8. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

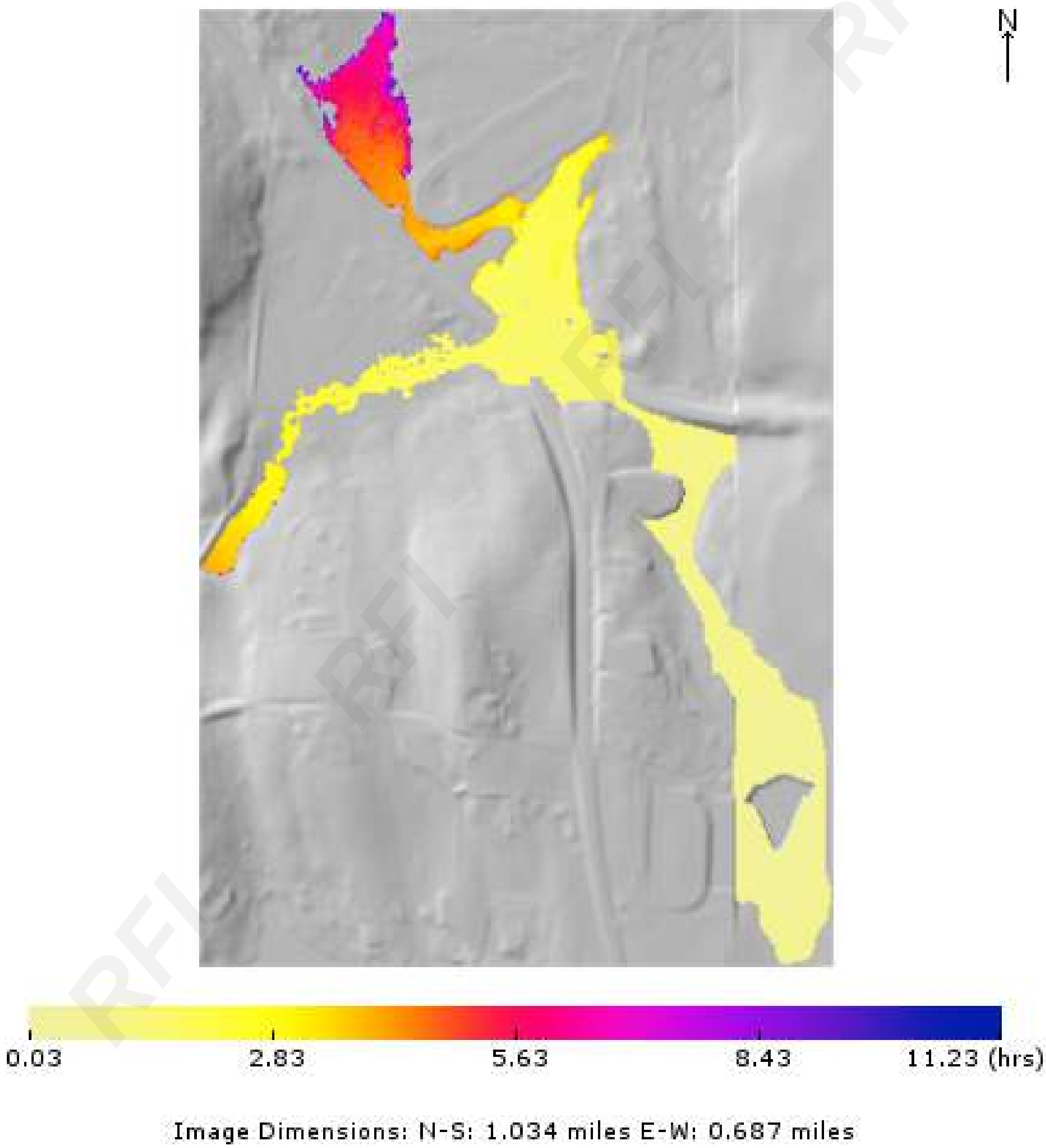


Figure 9. Flood Arrival Time Map.

4.6 Downloading Simulation Results

The simulation results can be accessed at the following web address:

https://dsswiseweb.ncche.olemiss.edu/download

Job ID: 74035

Attachment E

Rainy-Day Simulation Report

HALEY ALDRICH

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

DSS-WISE™ Lite Flood Simulation Report

Hydrograph-type, sudden and complete br
each

Rainy Day Breach - Old Duck Pond

NAXXXXX

February 22, 2024

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

FOR OFFICIAL USE ONLY

Table of Contents

1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
`https://dsswiseweb.ncche.olemiss.edu`

Disclaimer

Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Rainy Day Breach - Old Duck Pond
Scenario Name:	Hydrograph-type, sudden and complete br each
NIDID:	NAXXXXX
Scenario Description:	1 active reservoir 1 active impounding structure hydrograph-type, sudden and c omplete breach of Dam 1
User e-mail:	ahaneke@haleyaldrich.com
Group:	MASSACHUSETTS

2.2 Simulation Parameters

Domain buffer distance (miles):	10
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	5

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Dam 1
Structure Type:	Embankment
Hydraulic Height (ft):	12.0
Crest Elevation (ft):	1144.26
Length (ft):	370.813156292

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 User-Drawn Levees

Number of User-Drawn Levees: 0

2.6 User-Specified Breach Hydrograph

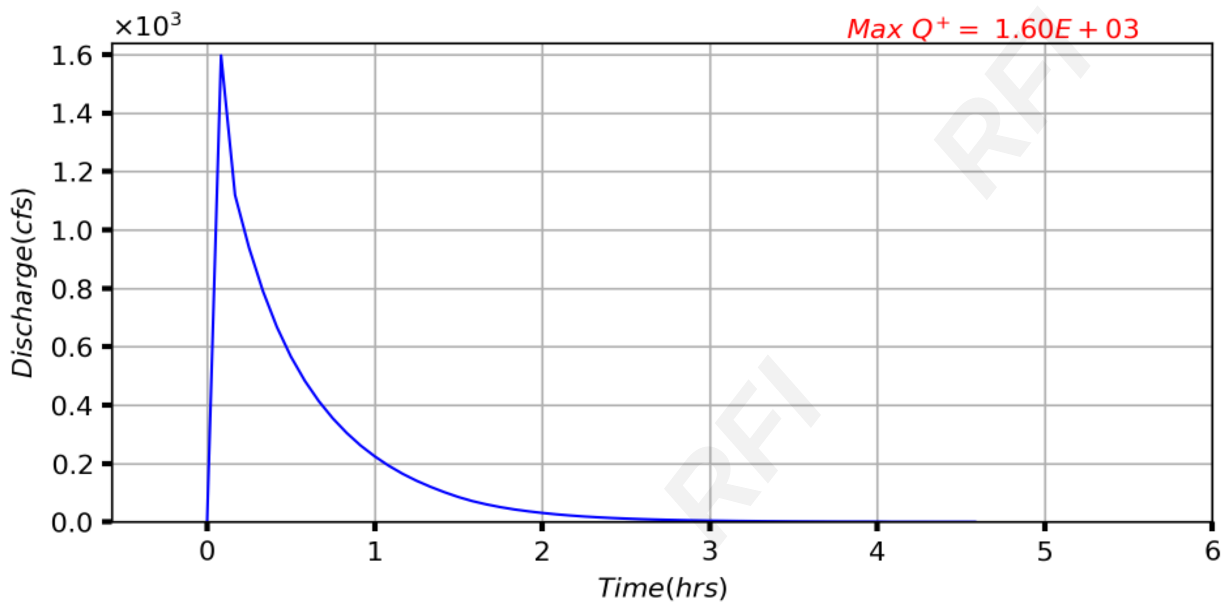


Figure 1. Breach inflow hydrograph for: Dam 1.

2.7 Reservoir Characteristics

Number of Reservoirs: 1

Reservoir Name:	Reservoir 1
Selected Reservoir Point (Latitude/Longitude):	42.5977287693/-71.9841222979
Pool Elevation @ Max Storage (ft):	1145.76
Maximum Storage Volume (ac-ft):	61.4
Pool Elevation @ Normal Storage (ft):	1144.26
Normal Storage Volume (ac-ft):	26.6
Pool Elevation @ Failure (ft):	1145.76
Failure Storage Volume (ac-ft):	61.4

2.8 Failure Conditions

Structure Name:	Dam 1
Structure Type:	Embankment
Failure Mode:	Total Dam Breach
Breach Location (Latitude/Longitude):	42.5978205568/-71.984286

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.
2. Burn U.S. Army Corps of Engineers (USACE) levee lines and group-specific levee lines (if any) within the AOI, as well as any user-drawn levees into the DEM.
3. Assign Manning's coefficients based on LULC classifications.
4. Validate user provided simulation input parameters.
5. Remove user identified bridges from the DEM.
6. Estimate reservoir bathymetry.
7. Extend impounding structures if the specified reservoir level cannot be contained.
8. Fill reservoir to specified failure elevation.
9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

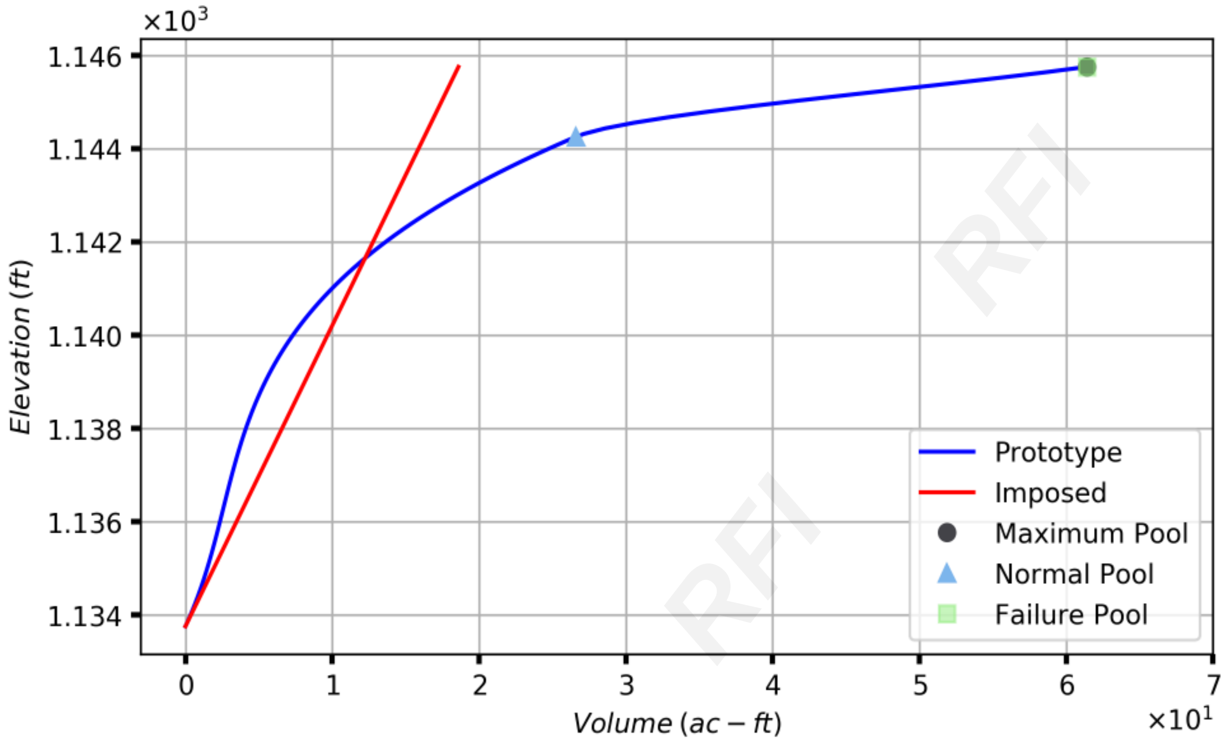


Figure 2. Stage-Volume Curve for Reservoir: Reservoir 1.

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.
Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.
User-given Storage Volume at Failure (ac-ft): 61.4
Imposed Storage Volume at Failure (ac-ft): 18.6
After filling to the failure elevation, the imposed reservoir volume matched 30.3% of the prototype volume.

Extended Structures:
Dam 1 has been extended to contain the reservoir.

3.3 Data Sources

1. Digital Elevation Models

   Sources: USGS 3D Elevation Program (3DEP) 2019 datasets, NOAA, and any group-specific DEM data if provided

   Resolutions: 2, 1, 1/3, and 1/9th arc-second, 1 meter, and varying resolutions of group-specific DEM data (if any), based upon availability

   Vertical Datum: NAVD88

   Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

   Sources: USGS 2016 (CONUS), 2011 (Alaska), and 2001 (Hawaii and Puerto Rico)

   Resolution: 30 m

3. National Levee Database

   Source: USACE

4. Group-specific levee data

   Source: Provided by individual groups

3.4 Digital Elevation Model

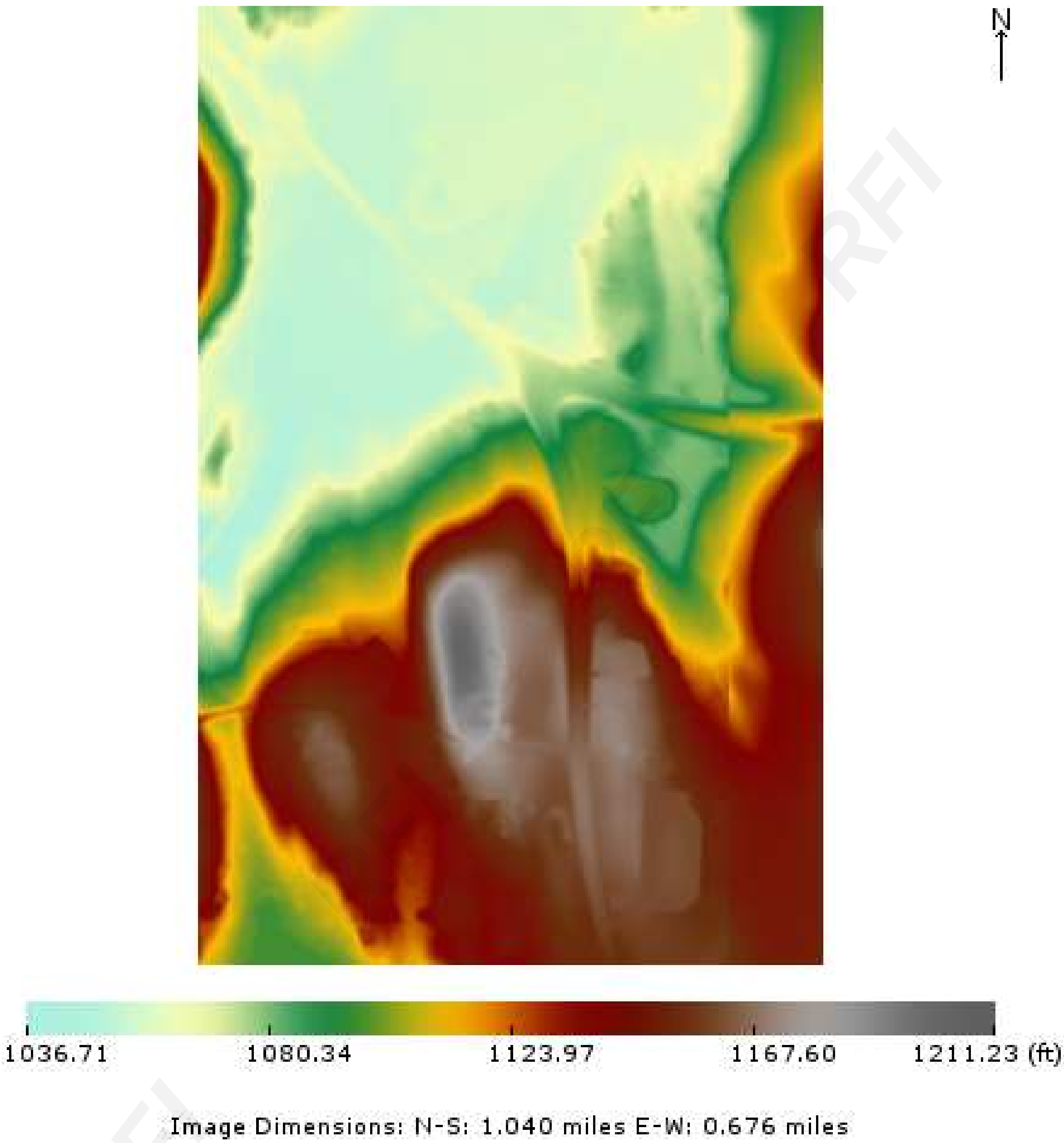


Figure 3. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

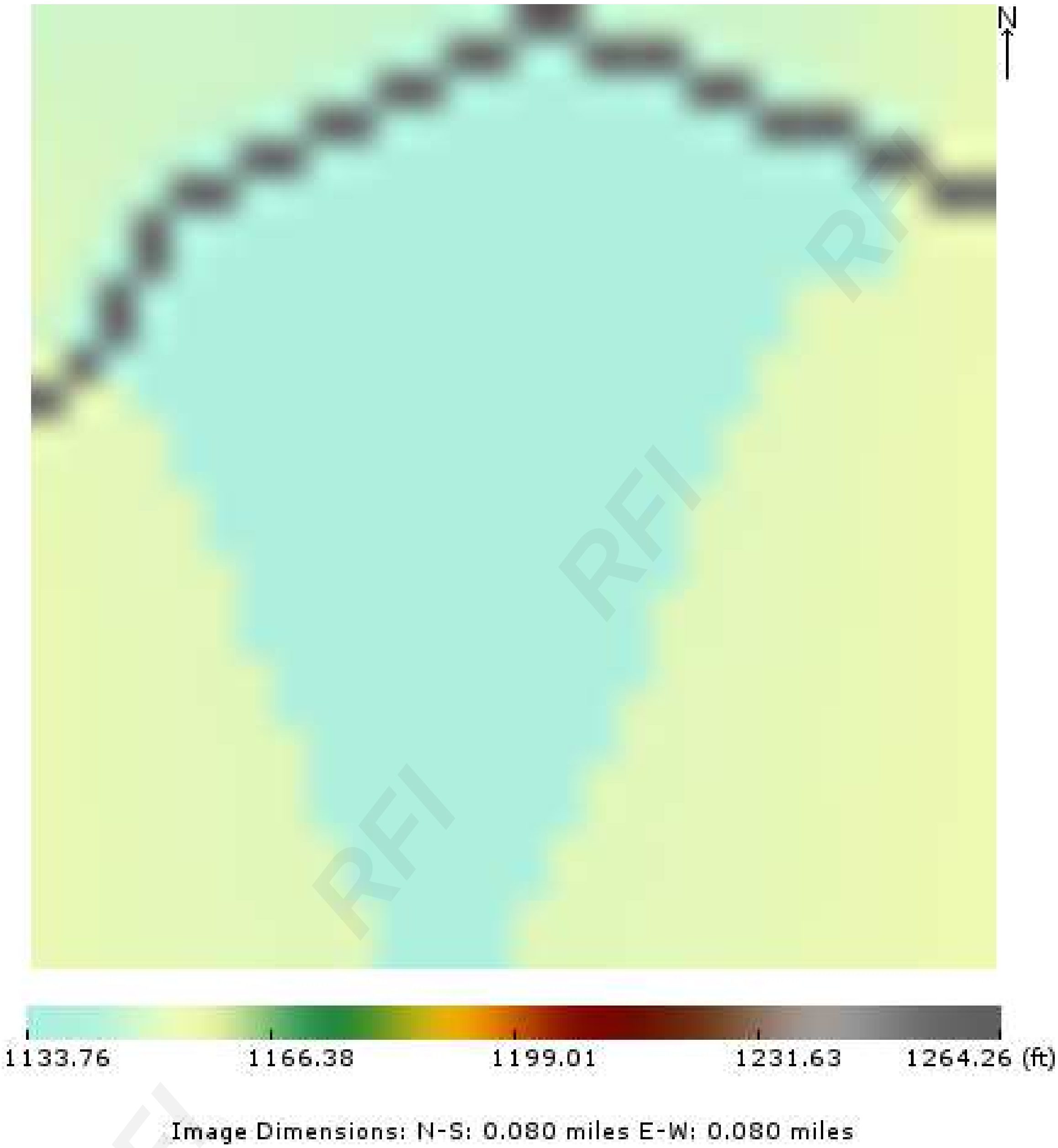


Figure 4. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

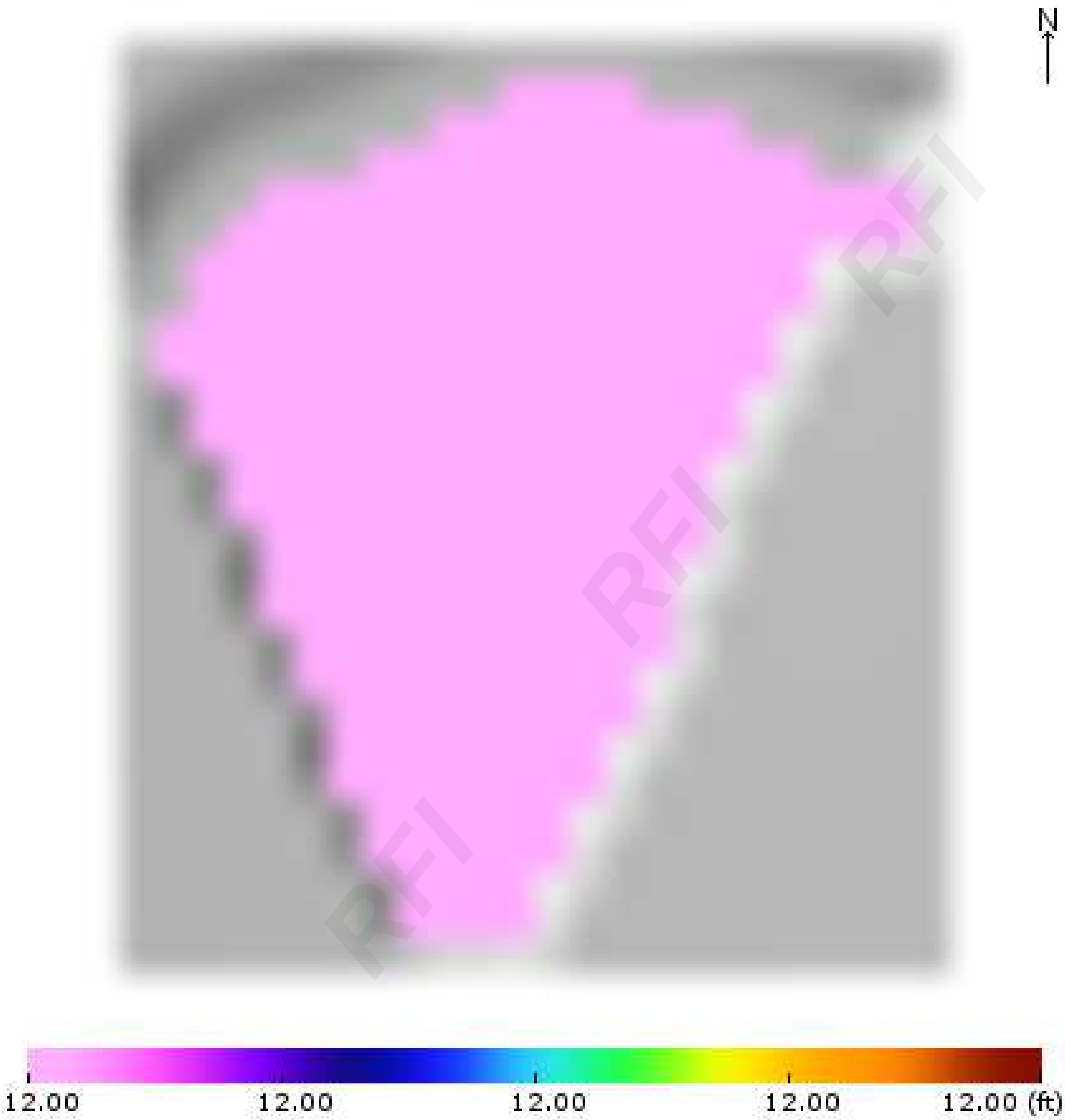


Image Dimensions: N-S: 0.082 miles E-W: 0.074 miles

Figure 5. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover

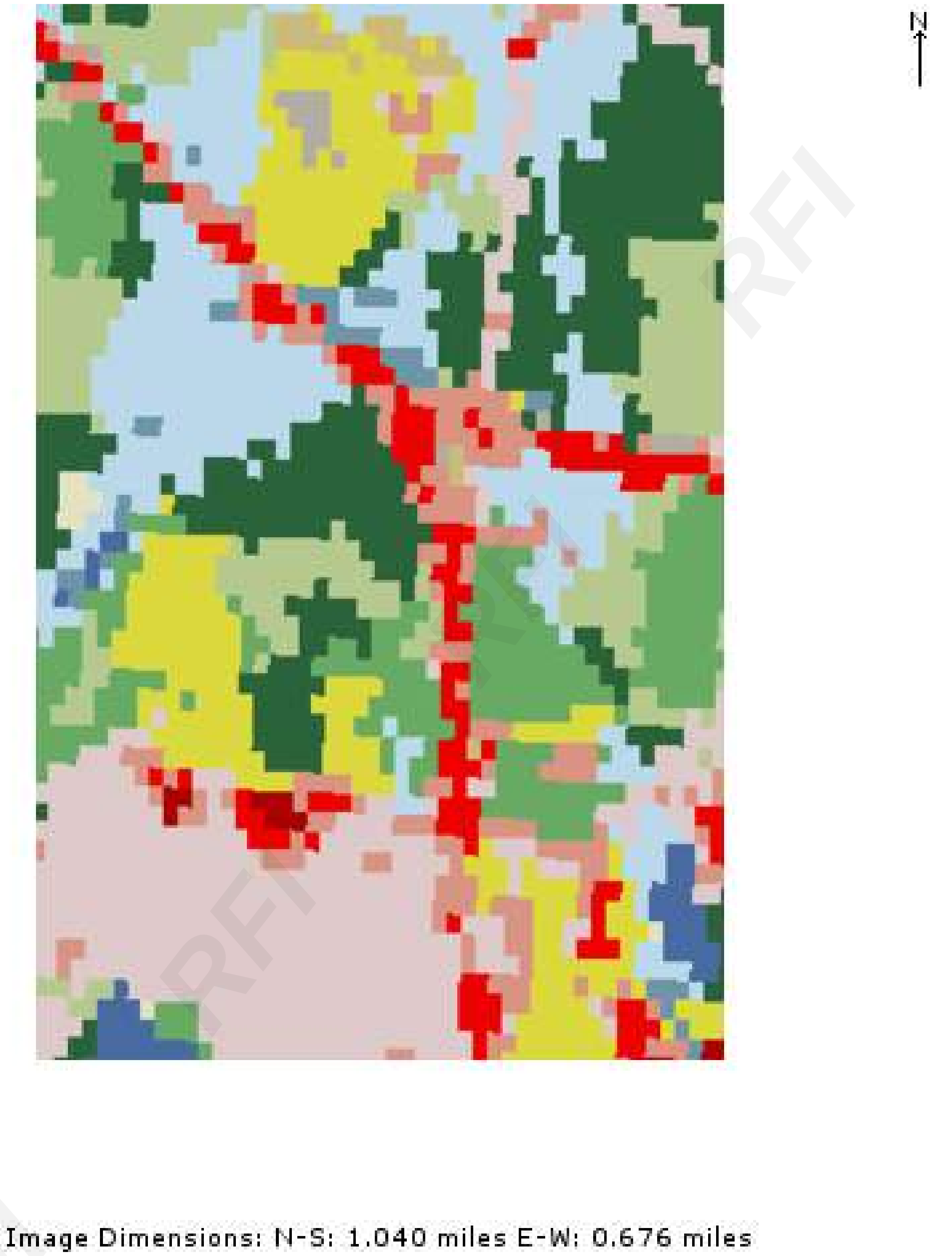


Figure 6. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	11:08 AM CST (02/22/2024)
Simulation Start Time:	11:09 AM CST (02/22/2024)
Simulation End Time:	11:11 AM CST (02/22/2024)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	0.9
Domain buffer distance (miles):	10
Elapsed simulation time after breach initiation (hrs):	11.4
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Woody Wetlands	45.42	0.1500	90	
Developed, Low Density	9.26	0.0678	22	
Hay/Pasture	9.22	0.0350	81	
Evergreen Forest *	7.48	0.1000	42	
Emergent Herbaceous Wetlands	7.20	0.1825	95	
Developed, Open Space	5.59	0.0404	21	
Open Water	4.89	0.0330	11	
Developed, Medium Density	4.60	0.0678	23	
Mixed Forest *	3.52	0.1200	43	
Deciduous Forest *	2.24	0.1000	41	
Barren Land	0.27	0.0113	31	
Grassland/Herbaceous	0.23	0.0400	71	
Unclassified	0.00	0.0350	0	
Perennial Snow/Ice	0.00	0.0100	12	
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Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	
Cultivated Crops	0.00	0.0700	82	

Note: * indicates an n-value estimated by NCCHE. ** indicates an n-value given by the user. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets

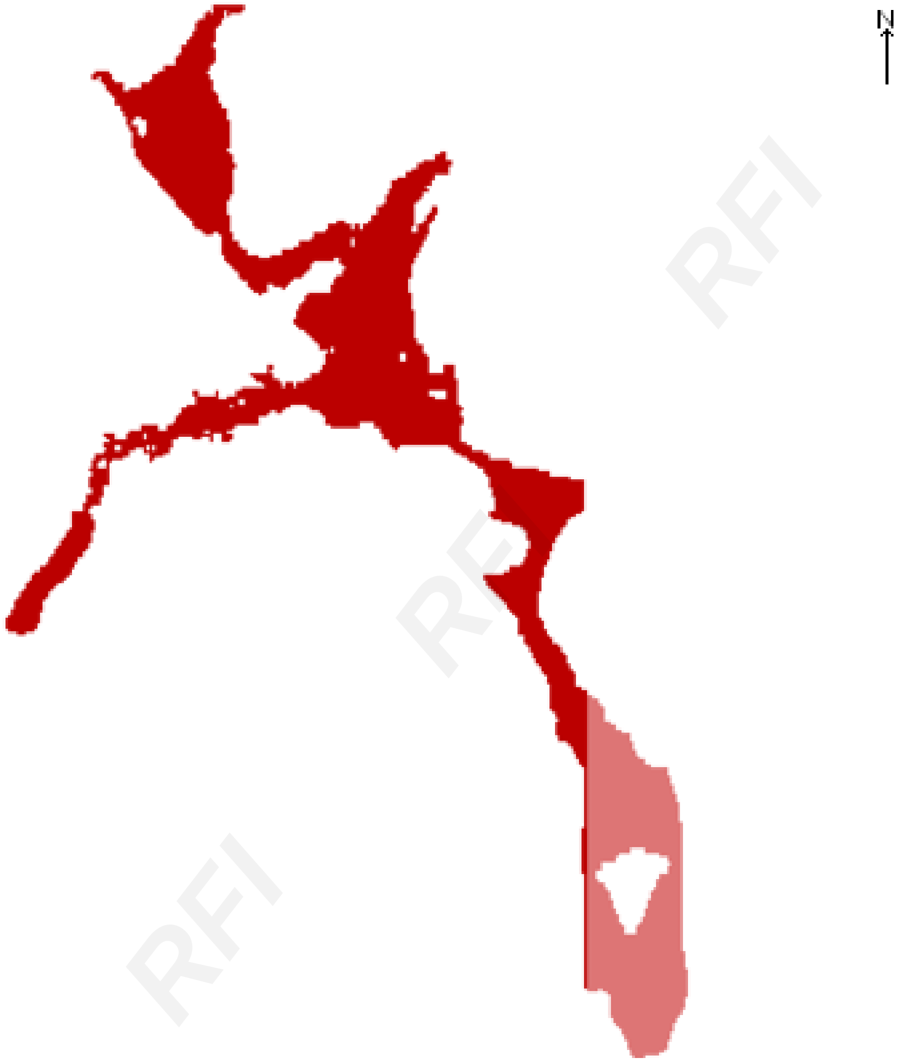


Figure 7. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	
USGS	1 meter	usgs_utm_z19_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

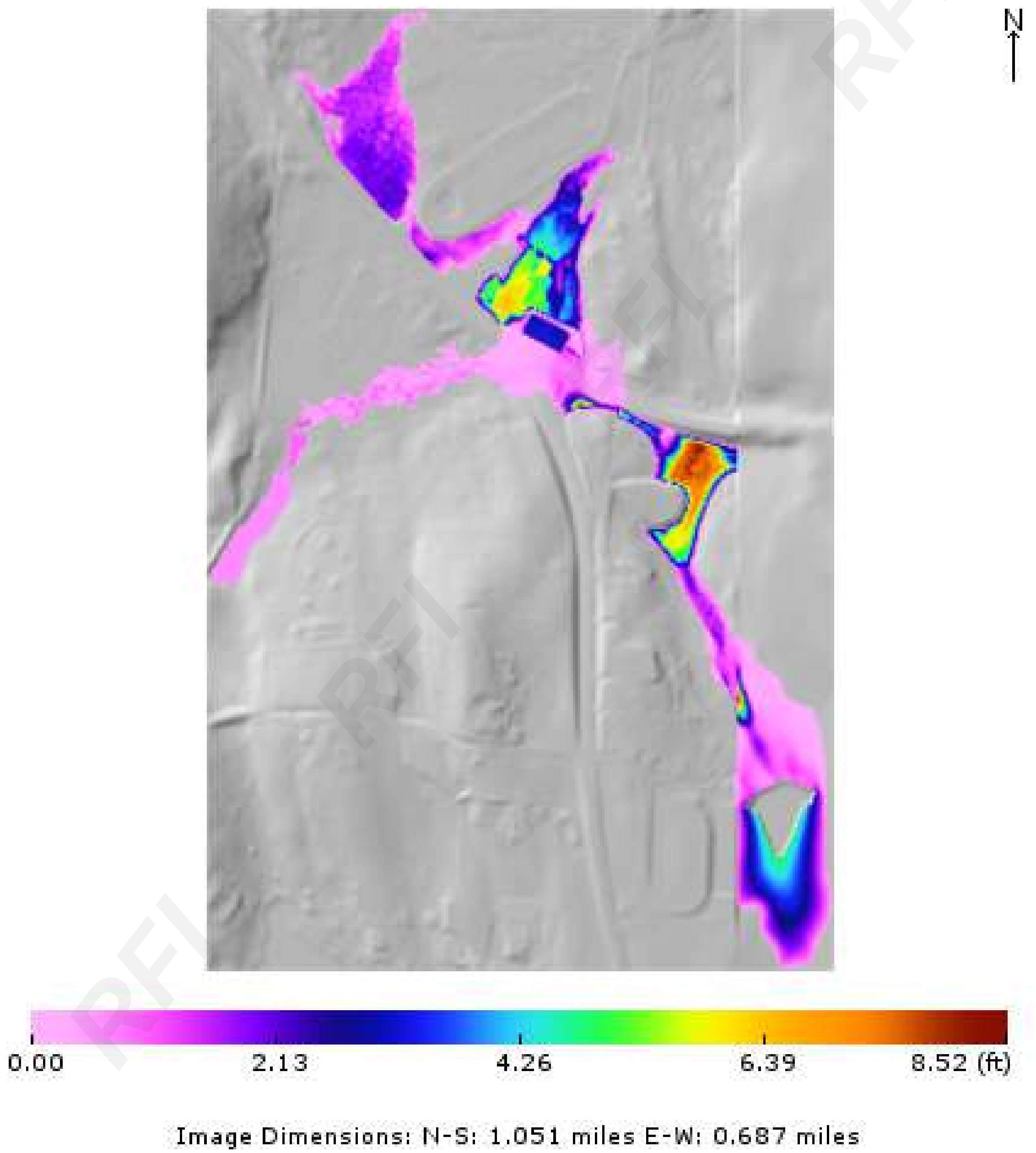


Figure 8. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

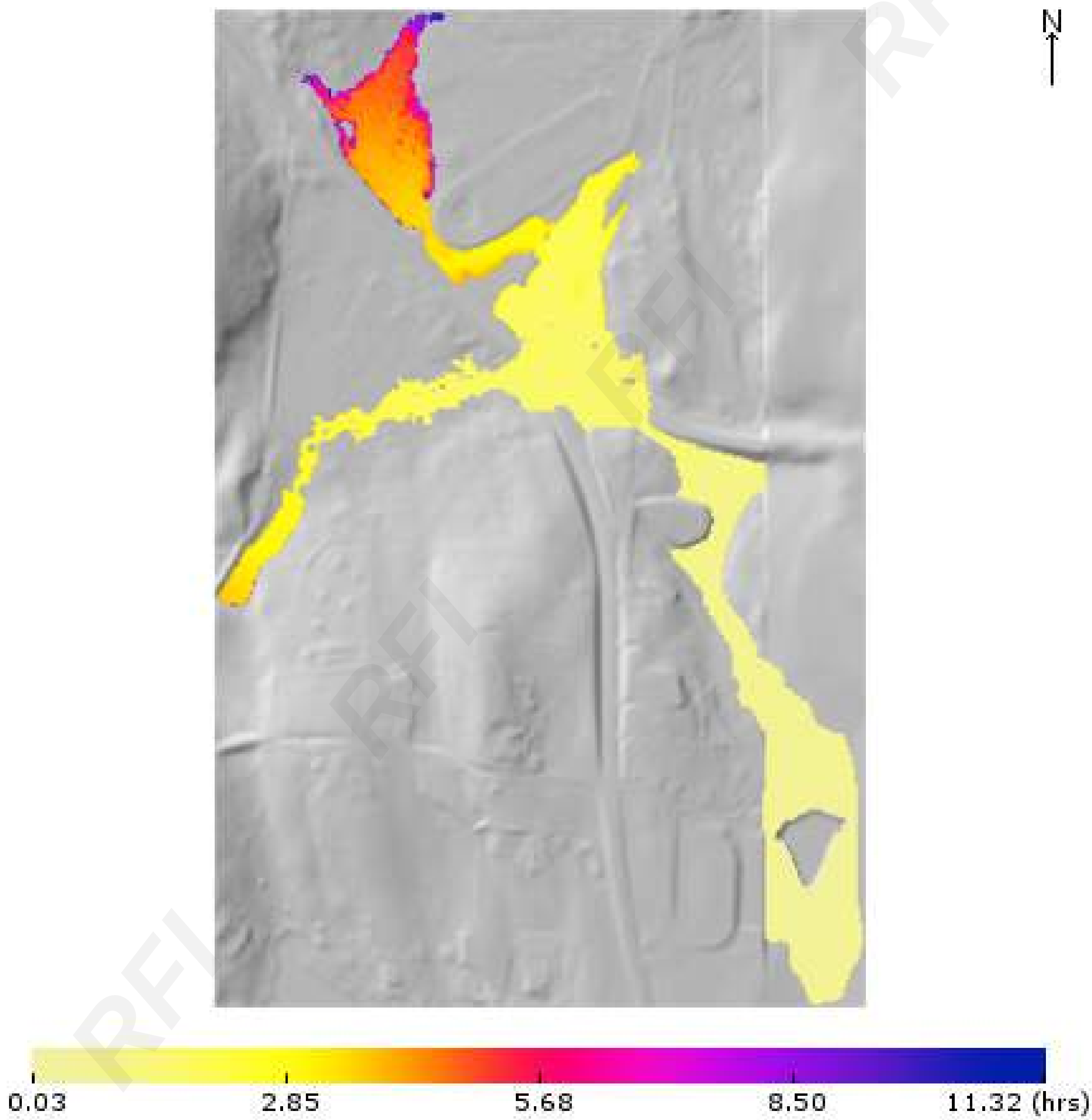


Image Dimensions: N-S: 1.051 miles E-W: 0.687 miles

Figure 9. Flood Arrival Time Map.

4.6 Downloading Simulation Results

The simulation results can be accessed at the following web address:

https://dsswiseweb.ncche.olemiss.edu/download

Job ID: 74036

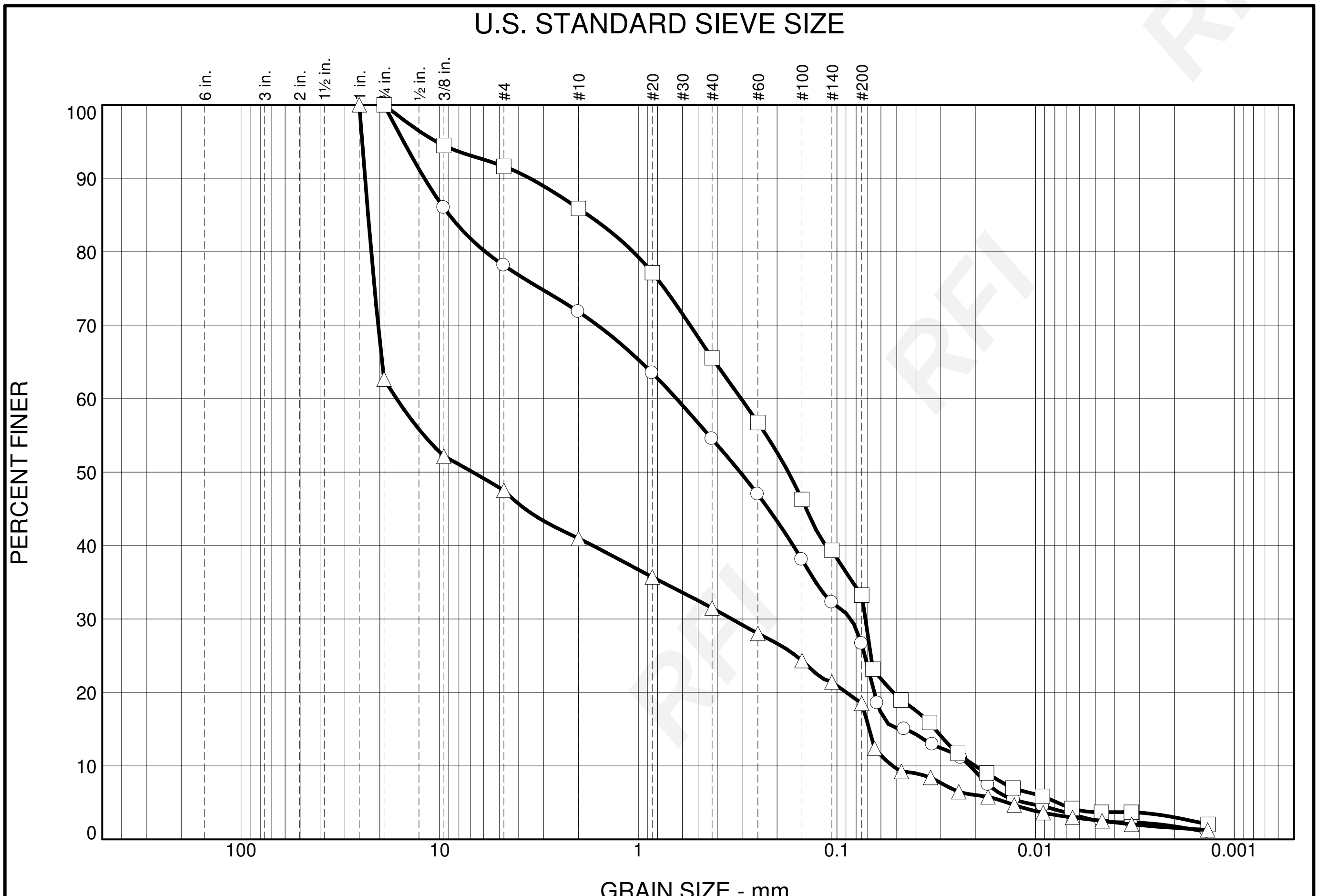
TABLE I
SUMMARY OF CHEMICAL ANALYTICAL RESULTS
SOIL SAMPLES
OLD DUCK POND DAM
MOUNT WACHUSETT COMMUNITY COLLEGE
GARDNER, MASSACHUSETTS
FILE NO. 029913-028

Location Name Sample Name Sample Date Lab Sample ID Sample Depth (bgs) Soil Description	MCP Reportable Concentration RCS-1 2024	HA24-101 HA24-101_0-5 09/23/2024 L2454565-01 0 - 5 (ft) FILL	HA24-101 HA24-101_5-8 09/23/2024 L2454565-02 5 - 8 (ft) FILL	HA24-102 HA24-102_0-5 09/20/2024 L2454367-01 0 - 5 (ft) FILL	HA24-102 HA24-102_5-9 09/20/2024 L2454367-02 5 - 9 (ft) FILL	HA24-103 HA24-103_0-5 09/19/2024 L2454018-01 0 - 5 (ft) FILL	HA24-103 HA24-103_5-10 09/19/2024 L2454018-02 5 - 10 (ft) FILL	HA24-104 HA24-104_0-5 09/18/2024 L2453671-01 0 - 5 (ft) FILL	HA24-104 HA24-104_5-10 09/18/2024 L2453671-02 5 - 10 (ft) FILL
Volatile Organic Compounds (mg/kg)									
2-Butanone (Methyl Ethyl Ketone)	4	ND (0.01)	0.042	ND (0.0093)	ND (0.0095)	ND (0.0077)	ND (0.011)	ND (0.012)	ND (0.0092)
Acetone	6	ND (0.026)	0.2	ND (0.023)	ND (0.024)	ND (0.019)	ND (0.027)	ND (0.031)	ND (0.023)
SUM of Volatile Organic Compounds	NA	ND	0.242	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds (mg/kg)									
Acenaphthylene	2	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.32	ND (0.15)
Anthracene	1000	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.18	ND (0.11)
Benzo(a)anthracene	20	ND (0.11)	ND (0.15)	0.11	ND (0.11)	ND (0.6)	ND (0.11)	0.58	ND (0.11)
Benzo(a)pyrene	2	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.76	ND (0.15)
Benzo(b)fluoranthene	20	ND (0.11)	ND (0.15)	0.13	ND (0.11)	ND (0.6)	ND (0.11)	0.91	ND (0.11)
Benzo(g,h,i)perylene	1000	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.54	ND (0.15)
Benzo(k)fluoranthene	200	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.29	ND (0.11)
bis(2-Ethylhexyl)phthalate	100	ND (0.19)	ND (0.24)	ND (0.18)	ND (0.19)	ND (0.99)	0.3	ND (0.18)	ND (0.19)
Chrysene	200	ND (0.11)	ND (0.15)	0.12	ND (0.11)	ND (0.6)	ND (0.11)	0.63	ND (0.11)
Dibenz(a,h)anthracene	2	ND (0.08)	ND (0.1)	ND (0.076)	ND (0.08)	ND (0.42)	ND (0.077)	0.1	ND (0.078)
Fluoranthene	1000	ND (0.11)	ND (0.15)	0.16	ND (0.11)	ND (0.6)	ND (0.11)	1.2	ND (0.11)
Indeno(1,2,3-cd)pyrene	20	ND (0.15)	ND (0.2)	ND (0.14)	ND (0.15)	ND (0.8)	ND (0.15)	0.44	ND (0.15)
Phenanthrene	10	ND (0.11)	ND (0.15)	ND (0.11)	ND (0.11)	ND (0.6)	ND (0.11)	0.54	ND (0.11)
Pyrene	1000	ND (0.11)	ND (0.15)	0.18	ND (0.11)	ND (0.6)	ND (0.11)	1.1	ND (0.11)
SUM of Semi-Volatile Organic Compounds	NA	ND	ND	0.7	ND	ND	0.3	7.59	ND
Total Petroleum Hydrocarbons (mg/kg)									
Petroleum hydrocarbons	1000	ND (38.3)	147	52.6	53.8	106	ND (35.8)	103	ND (37)
Inorganic Compounds (mg/kg)									
Antimony	20	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Arsenic	20	8.88	10.8	11.5	12.5	12.5	11.9	15.5	14.5
Barium	1000	24.6	37.9	42.7	102	61.3	87.4	36	38.8
Beryllium	100	ND (0.44)	ND (0.581)	ND (0.418)	ND (0.45)	ND (0.48)	ND (0.44)	ND (0.444)	ND (0.433)
Cadmium	80	ND (0.88)	ND (1.16)	ND (0.835)	ND (0.9)	ND (0.961)	ND (0.881)	ND (0.888)	ND (0.866)
Chromium	100	9.12	14.7	16.2	25.3	23.3	37.8	16.2	14.1
Lead	200	7.06	13.5	7.84	5.97	8.33	ND (4.4)	7.3	5.57
Mercury	20	ND (0.076)	ND (0.105)	ND (0.077)	ND (0.082)	ND (0.085)	ND (0.078)	ND (0.082)	ND (0.073)
Nickel	700	6.07	6.22	9.42	13	13	22.1	8.65	7.9
Selenium	400	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Silver	100	ND (0.88)	ND (1.16)	ND (0.835)	ND (0.9)	ND (0.961)	ND (0.881)	ND (0.888)	ND (0.866)
Thallium	8	ND (4.4)	ND (5.81)	ND (4.18)	ND (4.5)	ND (4.8)	ND (4.4)	ND (4.44)	ND (4.33)
Vanadium	500	11.1	17.2	15.4	31.1	21.1	24.1	15.1	13.4
Zinc	1000	18.5	28.2	28	44.7	36	26	25.2	22.8
PCBs (mg/kg)									
Aroclor-1016 (PCB-1016)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1221 (PCB-1221)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1232 (PCB-1232)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1242 (PCB-1242)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1248 (PCB-1248)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1254 (PCB-1254)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1260 (PCB-1260)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1262 (PCB-1262)	NA	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Aroclor-1268 (PCB-1268)	NA	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Polychlorinated biphenyls (PCBs)	1	ND (0.0536)	ND (0.0703)	ND (0.0531)	ND (0.0546)	ND (0.0608)	ND (0.0999)	ND (0.0546)	ND (0.0565)
Other									
Total Solids (%)	NA	86.5	66.6	90.9	86	81.5	90	89.7	87.3
Reactive Cyanide (mg/kg)	NA	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)
Reactive Sulfide (mg/kg)	NA	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)
Ignitability (Flashpoint)	NA	NI	NI	NI	NI	NI	NI	NI	NI
pH (lab) (pH units)	NA	6.89	6.8	7.7	7.64	7.11	6.92	8.18	8.21
Conductivity (umhos/cm)	NA	22	22	21	24	15	24	25	33

TABLE II
SUMMARY OF CHEMICAL ANALYTICAL RESULTS
SEDIMENT SAMPLES
OLD DUCK POND DAM
MOUNT WACHUSETT COMMUNITY COLLEGE
GARDNER, MASSACHUSETTS
File No. 029913-028

Precharacterization Grid						
Location Name	HA24-SED-201	HA24-SED-202	HA24-SED-203	HA24-SED-204	HA24-SED-205	HA24-SED-206
Sample Name	HA24-SED-201_0-2	HA24-SED-202_0-2	HA24-SED-203_0-2	HA24-SED-204_0-2	HA24-SED-205_0-2	HA24-SED-206_0-2
Sample Date	11/12/2024	11/12/2024	11/12/2024	11/12/2024	11/12/2024	11/12/2024
Lab Sample ID	L2466236-06	L2466236-05 L2467789-01	L2466236-04	L2466236-03 L2467789-03	L2466236-02 L2467789-02	L2466236-01
Sample Depth (bgs)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)	0 - 2 (ft)
Volatile Organic Compounds (mg/kg)						
2-Butanone (Methyl Ethyl Ketone)	0.37	0.32	0.22	0.26	0.12	0.28
Acetone	1.4	1.3	1.1	1.1	0.5	1.1
SUM of Volatile Organic Compounds	1.77	1.62	1.32	1.36	0.62	1.38
Semi-Volatile Organic Compounds (mg/kg)						
Benzo(b)fluoranthene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	3.4	2.3
Chrysene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	2.5	ND (1.8)
Fluoranthene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	5.1	2.9
Pyrene	ND (3.1)	ND (2)	ND (1.9)	ND (2.1)	3.6	2.1
SUM of Semi-Volatile Organic Compounds	ND	ND	ND	ND	14.6	7.3
Total Petroleum Hydrocarbons (mg/kg)						
Petroleum hydrocarbons	ND (483)	ND (336)	ND (309)	409	ND (311)	325
PCBs (mg/kg)						
Aroclor-1016 (PCB-1016)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1221 (PCB-1221)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1232 (PCB-1232)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1242 (PCB-1242)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1248 (PCB-1248)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1254 (PCB-1254)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1260 (PCB-1260)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1262 (PCB-1262)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Aroclor-1268 (PCB-1268)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Polychlorinated biphenyls (PCBs)	ND (0.502)	ND (0.327)	ND (0.322)	ND (0.337)	ND (0.312)	ND (0.292)
Inorganic Compounds (mg/kg)						
Antimony	**ND (40.2)**	**ND (27.6)**	**ND (25.6)**	**ND (28.9)**	**ND (25.7)**	**ND (23.7)**
Arsenic	10.4	**24**	9.65	11.2	**25.4**	15.3
Barium	89.8	86.7	56.1	63.2	80.6	64.6
Beryllium	ND (4.02)	ND (2.76)	ND (2.56)	ND (2.89)	ND (2.57)	ND (2.37)
Cadmium	ND (8.05)	ND (5.52)	ND (5.11)	ND (5.78)	ND (5.14)	ND (4.74)
Chromium	11.2	23.8	8.81	12.6	29.4	21.8
Lead	45.5	105	ND (25.6)	107	133	75.3
Mercury	ND (0.764)	ND (0.476)	ND (0.429)	ND (0.474)	ND (0.416)	ND (0.443)
Nickel	ND (20.1)	20.4	ND (12.8)	15.6	21.4	16.9
Selenium	ND (40.2)	ND (27.6)	ND (25.6)	ND (28.9)	ND (25.7)	ND (23.7)
Silver	ND (8.05)	ND (5.52)	ND (5.11)	ND (5.78)	ND (5.14)	ND (4.74)
Thallium	**ND (40.2)**	**ND (27.6)**	**ND (25.6)**	**ND (28.9)**	**ND (25.7)**	**ND (23.7)**
Vanadium	11.6	34	7.33	20.3	41.1	21.2
Zinc	120	408	38.5	191	479	183
TCLP Inorganic Compounds (mg/L)						
Lead	-	ND (0.5)	-	ND (0.5)	ND (0.5)	-
Other						
Total Solids (%)	9.64	14	14.8	13.8	15.3	16.2
Reactive Cyanide (mg/kg)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)	ND (130)
Reactive Sulfide (mg/kg)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)	ND (250)
Ignitability (Flashpoint)	NI	NI	NI	NI	NI	NI
pH (lab) (pH units)	6.13	5.97	5.77	5.45	5.8	5.49
Conductivity (umhos/cm)	300	270	230	270	330	480

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
mg/L: milligram per liter
umhos/cm: micromhos per centimeter



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	21.9	6.3	17.3	27.9	24.8	1.8
□	0.0	0.0	8.4	5.7	20.3	32.3	30.3	3.0
△	0.0	37.3	15.2	6.5	9.5	13.0	16.9	1.6

	Expl. No.	Sample No.	Depth (ft)	Atterberg Limits % W_L	W_P	I_P	Water Content (%)	C_u	C_c	USCS
○	HA24-101	S05	8.0-10.0				17.7	30.03	0.53	SM
□	HA24-102	S02	2.0-4.0				22.7	15.08	0.85	SM
△	HA24-104	S05	14.0-15.4				13.0	314.98	0.13	GM

	Sample Description
○	Light brown silty sand with gravel
□	Yellow-brown silty sand
△	Light brown silty gravel with sand

Remarks:

Samples HA24-101 S05 and HA24-102 S02 contained less than 500 grams of material available for testing in accordance with ASTM D422.

HALEY ALDRICH

Old Duck Pond
Gardner, Massachusetts

GRAIN SIZE DISTRIBUTION

DATE: 10/7/2024

FILE NO: 029913-028